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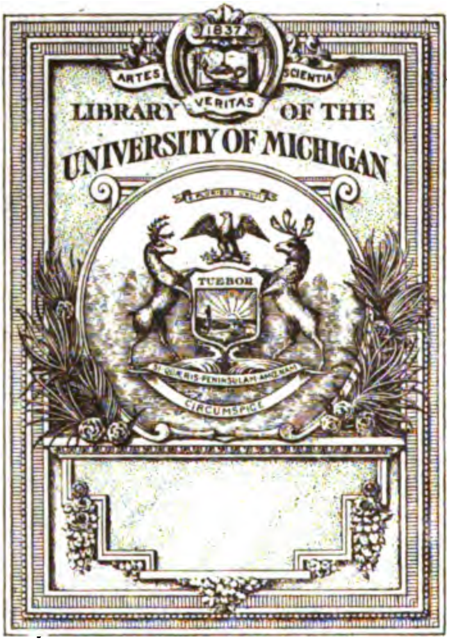

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PROCEEDINGS

OF THE

American Gas Institute

ELEVENTH ANNUAL MEETING

OCTOBER 17, 18, 19, 20, 1916

CHICAGO, ILL.

Part I

PUBLISHED BY THE INSTITUTE
EDITED BY THE PUBLICATION COMMITTEE
1917

PRESS OF
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EASTON, PA.

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1916-1917

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Geo. B. Evans,	Manufacturing Section	St. Louis, Mo.

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Geo. G. Ramsdell...................................New York, N. Y.

Directors

		Term expires
Dana D. Barnum	Worcester, Mass	1917
R. B. Brown	Milwaukee, Wis.	1917
Chas. M. Cohn	Baltimore, Md.	1917
G. B. Cortelyou	New York, N. Y.	1917
Robert B. Harper	Chicago, Ill.	1917
H. C. Abell	New York, N. Y.	1918
Albert M. Barnes	Cambridge, Mass.	1918
Owen B. Evans	Philadelphia, Pa.	1918
Hilmar M. Papst	Portland, Ore.	1918
Theodore V. Purcell	Chicago, Ill.	1918
William E. McKay	Boston, Mass.	*Ex-Officio*

Affiliation Representatives

Geo. F. Goodnow,	Illinois Gas Association	Waukegan, Ill.
J. W. Dunbar,	Indiana Gas Association	New Albany, Ind.
A. L. English,	Iowa District Gas Association	Council Bluffs, Ia.
V. F. Dewey,	Michigan Gas Association	Detroit, Mich.
H. K. Morrison,	New England Association of Gas Engineers	Lynn, Mass.
C. H. Butcher,	New Jersey State Gas Association	Freehold, N. J.
F. P. Duggan,	Pennsylvania Gas Association	Lewiston, Pa.
S. E. DeFrese,	Southern Gas Association	Chattanooga, Tenn.
S. J. Glass,	Wisconsin Gas Association	Milwaukee, Wis.

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1915-1916

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J. D. von Maur,	Distribution Section	St. Louis, Mo.
C. O. Bond,	Illumination Section	Philadelphia, Pa.
Herman Russell,	Manufacturing Section	Rochester, N. Y.

Secretary and Treasurer

Geo. G. Ramsdell . . . . New York, N. Y.

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		Term expires
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J. W. Dunbar	New Albany, Ind.	1916
James Ferrier	Rome, Ga.	1916
J. B. Klumpp	Philadelphia, Pa.	1916
C. H. Nettleton	Derby, Conn.	1916
D. D. Barnum	Worcester, Mass.	1917
R. B. Brown	Milwaukee, Wis.	1917
C. M. Cohn	Baltimore, Md.	1917
G. B. Cortelyou	New York, N. Y.	1917
R. B. Harper	Chicago, Ill.	1917
E. C. Jones	San Francisco, Cal.	*Ex-Officio*

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S. J. Glass,	Wisconsin Gas Association	Milwaukee, Wis.
L. H. Johnson,	Illinois Gas Association	Sheboygan, Wis.
B. F. Cresson,	Pennsylvania Gas Association	Easton, Pa.
C. H. Butcher,	New Jersey State Gas Association	Freehold, N. J.
S. E. DeFrese,	Southern Gas Association	Chattanooga, Tenn.

PAST OFFICERS

Presidents

*B. W. Perkins	1906
Walton Clark	1906–1907
A. C. Humphreys	1907–1908
*C. F. Prichard	1908–1909
W. H. Bradley	1909–1910
Donald McDonald	1910–1911
I. C. Copley	1911–1912
W. R. Addicks	1912–1913
W. H. Gartley	1913–1914
E. C. Jones	1914–1915
William E. McKay	1915–1916

Secretaries

J. W. Dunbar	1906–1908
A. B. Beadle	1908–1911

* Deceased.

PAST OFFICERS OF THE MERGED ASSOCIATIONS

AMERICAN GAS LIGHT ASSOCIATION

1873-1906

Presidents

*Charles Roome	1873-79	Arthur E. Boardman	1893
*William H. Price	1880-81	William H. Pearson	1894
*Andrew Hickenlooper	1882	Walton Clark	1895
*Theobald Forstall	1883	C. J. R. Humphreys	1896
*William A. Stedman	1884	Chas. H. Nettleton	1897
*Eugene Vanderpool	1885	*J. B. Crockett	1898
*Austin C. Wood	1886	Alex. C. Humphreys	1899
Malcolm S. Greenough	1887	Geo. G. Ramsdell	1900
*Thomas Turner	1888	Edward G. Pratt	1901
*Alpheus B. Slater	1889	*Wm. R. Beal	1902
Emerson McMillin	1890	Alten S. Miller	1903
*John B. Harbison	1891	Rollin Norris	1904
*William Henry White	1892	E. G. Cowdery	1905

[1]*Charles F. Prichard 1906

Secretaries

*Henry Wurtz	1873	C. J. R. Humphreys	1884-91
*Peter E. Demill	1874	A. B. Slater, Jr	1892-96
*Chas. H. Nettleton, Sr.	1875–79	Alfred E. Forstall	1897-04
*William Henry White	1880–83	Geo. G. Ramsdell	1905-06

[1] Elected but did not serve owing to merger. * Deceased.

OHIO GAS LIGHT ASSOCIATION

1884-1906

Presidents

*Gen. A. Hickenlooper	1884-86
Emerson McMillin	1887
*Eugene Printz	1888
*Thomas Wood	1889
*Edw. Lindsley	1890
*Chas. R. Faben, Jr.	1891
*H. Wilkiemeyer	1892
Chas. H. Welch	1893
*Irvin Butterworth	1894
*J. W. R. Cline	1885
*Jos. Gwynn	1896
*Jerome Penn	1897
W. C. Boyle	1898
*B. P. Holmes, elected for	1899
*E. H. Jenkins	1899
A. P. Lathrop	1900
George Whysall	1901
Henry L. Doherty	1902
C. W. Andrews	1903
John D. McIlhenny	1904
F. W. Stone	1905
Donald McDonald	1906
[1]*B. W. Perkins	1907

Secretaries

*Joseph M. Bate	1884-85
*Irvin Butterworth	1886-93
Alanson P. Lathrop	1894-98
Thomas Clive Jones	1899-1906

WESTERN GAS ASSOCIATION

1878-1906

Presidents

*J. O. King	1878-80
*Thomas Butterworth	1881-82
*J. B. Howard	1883-84
T. G. Lansden	1885
*James Somerville	1886
*John Fullagar	1887
Emerson McMillin	1888
Geo. G. Ramsdell	1889
*E. G. King, Elected for	1890
*Charles R. Faben, Jr.	1890
Frederick Egner	1891
E. G. Cowdery	1892
*B. E. Chollar	1893
*E. H. Jenkins	1894
Isaac C. Baxter	1895
A. W. Littleton	1896
*W. H. Odiorne	1897
James T. Lynn	1898
*G. Treadway Thompson	1890
William McDonald	1900
I. C. Copley	1901
Thomas D. Miller	1902
A. H. Barret	1903
F. H. Shelton	1904
O. O. Thwing	1905
Paul Doty	1906
[1]*Kerr Murray Mitchell	1907

Secretaries

*Lee A. Hall	1878-82
James W. Dunbar	1895-06
A. W. Littleton	1882-94

[1] Elected but did not serve owing to merger. * Deceased.

COMMITTEES AND SUBCOMMITTEES.

GENERAL

Affiliation
L. R. Dutton, Chairman.
A. M. Barnes, F. A. Cressey, Jr.,
E. D. Brewer, Jas. W. Dunbar.

Analysis of Accidents
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Geo. Oliver Smith, Chas. B. Scott.

Arrangements
E. G. Cowdery, Chairman.
L. A. Wiley, Secretary.
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R. B. Brown, B. F. Lyons,
Robert Clark, A. D. Mackie,
Rufus Dawes, Carroll Miller,
A. B. Eaton, C. A. Munroe,
H. D. Harper, E. E. Morrell,
C. L. Holman, E. G. Pratt,
B. J. Kellum, G. D. Roper,
O. T. Knight, John Williamson

Election of New Members
C. O. Bond, Chairman.
D. D. Barnum, G. G. Ramsdell.
A. H. Elliott,

Finance
R. W. Bush, Chairman.
C. M. Cohn, S. J. Glass.

Next Place of Meeting
Geo. Beadenkopf, Chairman.
R. C. Congdon, John H. Eustace.

Nominating.
V. F. Dewey, Chairman.
Carroll Miller, H. B. McLean,
Walton Forstall, John Williamson

Publication Committee
William E. McKay, Chairman
G. B. Cortelyou, G. G. Ramsdell,
E. C. Jones, Herman Russell.

Revision of Constitution and By-Laws
Herman Russell, Chairman.
W. R. Addicks, E. C. Jones,
R. B. Brown, J. B. Klumpp,
E. G. Cowdery, C. H. Nettleton,
A. E. Forstall, J. D. Shattuck,
W. H. Gartley, C. N. Stannard.

Transportation

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V. F. Dewey,	Detroit.
E. H. Earnshaw,	Newark,
N. W. Gifford,	Boston,
J. F. Guffey,	Pittsburgh,
C. L. Holman,	St. Louis,
J. B. Klumpp,	Philadelphia,
J. A. Mason,	Baltimore.

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J. B. Klumpp, Secretary.
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J. A. Britton, J. L. Richards,
E. G. Cowdery, M. W. Stroud.

National Association of Railway Commissioners
Wm. McClellan, Chairman.
R. B. Brown, J. B. Klumpp.

National Gas Safety Code
W. R. Addicks, Chairman.
For personnel of committee see *News*, March, 1917 page 113.

Representatives National Fire Protection Association
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R. C. Congdon, E. C. Jones,
R. B. Harper, W. A. Wood.

TECHNICAL

Technical Committee
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C. O. Bond, R. B. Harper,
C. M. Cohn, Herman Russell,
J. P. Crowley, J. W. Shaeffer,
A. H. Elliott, C. C. Tutwiler,
O. B. Evans, E. C. Uhlig,
O. H. Fogg, J. D. von Maur,
J. F. Wing.

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O. B. Evans, O. A. Sinsel,
Donald M'Arthur, F.W. Seymour.

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G. S. Barrows, G. T. Macbeth.

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W. H. Fulweiler, C. J. Ramsburg,
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A. F. Kunberger, A. B. Way,
A. H. White.

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L. B. Elliot, F. C. Shepard.
W. D. Kelley,

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F. C. Millard, G. I. Vincent.

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R. B. Harper, Thomas Scofield,
Arthur Hewitt, C. H. Stone,
Bureau of Standards.

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O. B. Evans, H.C.Wehnert.

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Geo. S. Barrows, Chairman.

International Uniform System of Pipe Threads
W. Cullen Morris, Chairman.
A. S. Miller, H. Russell.

Misleading Statements
A. E. Forstall, Chairman.
A. H. Strecker, F. C. Weber,

TECHNICAL—(*Continued*)

Nomenclature.
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Ewald Haase, O. E. Norman,
A. Hurlburt, W. E. Saunders,
E. C. Jones, A. H. Strecker,
J. P. Kennedy, C. C. Thomas,
C. A. Luckenbach, A. H. White.

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R. A. Jayne, J. D. von Maur.
G. T. Macbeth,

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J. P. Crowley.

CHEMICAL SECTION
Dr. A. H. Elliott.

DISTRIBUTION SECTION
J. D. von Maur.

ILLUMINATION SECTION
C. O. Bond.

MANUFACTURING SECTION
H. C. Abell, Herman Russell.

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J. S. DeHart. H. Russell,
W. H. Fulweiler, J. H. Taussig,
J. P. Kennedy, H. L. Underhill.

Representatives on Joint National Committee on Electrolysis
J. A. Gould, Chairman.
A. F. Ganz, J. D. von Maur.

Representatives U. S. National Committee of International Commission on Illumination
W. H. Gartley, Chairman.
C. O. Bond, A. S. Miller.

Standard Tests
Dr. J. F. Wing, Chairman.
R. N. Davis, J. H. Taussig,
O. B. Evans, V. Von Starzenski.

Supplying Large Buildings with Gas
O. H. Fogg, Chairman.
A. P. Ewing, C.E.Reinicker,
D.E.Keppelmann, W. J. Serrill,
J. A. Norcross, J. D. von Maur.
J. S. McIlhenny,

Utilization of Gas Fuel Appliances
W. J. Serrill, Chairman.
G. S. Barrows, E. B. Myers.
W. J. Clark, J. A. Norcross,
H.C. Fritz, W. H. Pettes,
D.E.Keppelmann, G. D. Roper.

William J. McKay.

PRESIDENT

Report of the Proceedings

of the

American Gas Institute

Eleventh Annual Meeting

held at

Chicago, Illinois

October 17, 18, 19 and 20, 1916.

INSTITUTE MEETING.

Morning Session, Tuesday, October 17.

The eleventh annual meeting of the American Gas Institute was called to order in the Gold Room of the Congress Hotel, Chicago, Illinois, at 10 A. M., by the President, Mr. Wm. E. McKay, Mr. Geo. G. Ramsdell being in the Secretary's chair.

THE PRESIDENT: The meeting will come to order. I have pleasure in presenting to the Convention the gentleman who has taken from his very busy day the time to come to reenforce the welcome which we already feel, and to set forth more in detail his enthusiastic indorsement of the greeting to this Association in meeting in Chicago—Mr. John W. O'Leary, the President of the Chicago Association of Commerce. (Applause.)

ADDRESS OF WELCOME.

MR. O'LEARY: Mr. President, it is a great pleasure to have this opportunity of meeting the men who are responsible for so much warmth and light in this old world of ours, and particularly so when that meeting is in Chicago. You are representatives of a wonderful industry, an industry in which "progress" has been the slogan. Whether that slogan came through competition or ambition matters not; it is a wonderful slogan.

You began by furnishing to the people a luxury. You have continued until you are now furnishing them a necessity. And in that progress, that evolution, you have met and solved many problems; problems of service; problems of distribution; problems of production; but none of these problems is greater than the problem of your relation to the public you serve, and that problem you are meeting and meeting well.

We of Chicago know the value of having that problem met well. In our relations with our public utilities, we have only to think of our arrangements with our transportation companies, and remember that in the few years in which adjustment became the method of dealing, that we have entirely rehabilitated our transportation system; that we have offered improved facilities to the public; that we have ensured safety to the investor, and to the companies, while at the same time we have been putting in the public treasury millions of money for the further advancement of that particular field of public utility; and it is peculiarly fitting that you should hold this meeting in our city at a time when one of your members is negotiating in the same manner as our transportation companies negotiated.

We are rather proud of our gas company in Chicago; we are proud of its service; we are proud of its courtesy; we are proud of its progress; and I hope that before you have another meeting we will be able to say in Chicago that through adjustment and through negotiation we have reached a cordial relation with this great necessary public utility by adjustment, by fair dealing—rather than by endless litigation.

But I am not here to talk to you about the ethics of business, but rather to bid you, on behalf of the commercial and public interests of Chicago, a most hearty welcome. You are in an atmosphere of co-operation. We hope that you will have time from your deliberations to investigate our industries—particularly our gas company. They have had so much investigation lately, that I know they will welcome more. (Laughter.) That you will investigate our industries and note their virility; that you will take time to visit our mercantile institutions and note their completeness and efficiency; that you will take time to visit our parks, our boulevards, our lake front, and note their beauty; that you will take time to visit our art and educational institutions, and our amusements, and note their quality, and when you leave, as I assume you must, we hope that you will carry away with you a feeling that you have been associating with warm-blooded men; that their cordiality and hospitality have left with you a feeling of warmth and a desire that you may some day return and partake again.

I thank you. (Applause.)

THE PRESIDENT: I will ask Mr. Jones to reply.

MR. E. C. JONES: The President of the Association of Commerce of Chicago, Mr. President and gentlemen, it is a great pleasure to be called upon to express the thanks of the American Gas Institute to Mr. O'Leary for his kindly and cordial greeting and welcome to this wonderful city, and it is particularly pleasing to express this appreciation to a man like Mr. O'Leary, who is by profession a mechanical engineer, and is the head and front of a great body of over four thousand men—the Association of Commerce of Chicago who, I understand, are the leaders in the business world in this city—the men who do things. Mr. O'Leary is in a position to sympathize with us as gas men in our work and our ambitions.

It seems appropriate that the American Gas Institute should have its annual meeting in this city of commerce and industry and wealth. Chicago has all of these and is rapidly growing. Chicago is no longer away out west. In my boyhood I never hoped to get so far west as Chicago, but now coming from the Pacific Coast I look upon Chicago as an eastern city. I believe that our meeting in San Francisco last year during the Panama-Pacific International Exposition, pushed Chicago a little farther east. I think the trip to the Coast brought Chicago and New York closer together in the minds of the gas men. There was a time when we could not assemble this large body of men in Chicago from the American Gas Light Association or the American Gas Institute, but it seems to me that the magnet which drew the good men to San Francisco and made the distance of over 3,000 miles seem so short, has made the distance between New York and Chicago surely negligible. I feel that Chicago is good for the American Gas Institute, and I also feel that the American Gas Institute will be good for Chicago. It is impossible to bring together a body of men of the stamp of these men; the men who are the brains and brawn of one of the greatest industries in the world, without sowing seeds of good. The gas business, as you all know, and as Mr. O'Leary has aptly said, manufactures a commodity which is now a necessity, furnishing light, warmth and the best, most economical and efficient fuel in the world. It is best, most economical and most efficient for all of those purposes.

We have no competitors, excepting ourselves. Our own belief in gas is that which will make us succeed in building up our business—not to what it should be by natural growth, but to what it is bound to be by our enthusiastic efforts. These men around us to-day are the men who have made the gas business what it is to-day, they and their predecessors. They owe to their predecessors what they are to-day, because it has been a progressive evolution and growth through the hundred years of our business to the present status, when we are on the threshold of placing gas where it belongs and where it will stay.

Gentlemen, we owe Mr. O'Leary our heartfelt thanks for his kindly greeting, and in a simple way I have tried to express them to him, and I feel sure you join with me when I say, that we appreciate his taking the time from his business this morning to come here to greet us, that we thank him from our hearts. (Applause.)

THE PRESIDENT: The next business in order is the report of the Board of Directors, which the Secretary will now read.

REPORT OF THE BOARD OF DIRECTORS.

Meetings were held November 11, December 9, 1915; January 13, February 10, March 23, May 11, September 14, and October 16, 1916. All of these meetings were held at the Institute headquarters, except those of March 23 and October 16, which were held in Chicago.

The meetings have been fully reported in the Gas Institute *News* with statements of the business of importance as transacted.

Larger quarters have been leased and are occupied by the Institute. In May the Directors voted the appointment of an Assistant Secretary at a salary of $2,000.00 per annum.

The Directors have approved the following reports:

Secretary and Treasurer.

Technical Committee.

Public Relations Committee.

The Committee Reports and Papers to be read at this Meeting.

At the March meeting of the Board, the possible union of the Institute and the National Commercial Gas Association was discussed, and referred to the Committee on Revision of the Constitution, Mr. Herman Russell, Chairman. This was followed by conferences and correspondence, and further discussion of the subject at the Directors' meeting in July, at which, unfortunately, Mr. Russell was unable to be present. His subsequent illness, and other contributing circumstances, leave the matter in abeyance and without definite progress to report.

The Institute has made a new affiliation agreement with the Illinois, Iowa and Wisconsin Gas Associations, and has made affiliation agreements with the New England Association of Gas Engineers, the New Jersey State Gas Association, the Pennsylvania Gas Association, the Southern Gas Association, the Indiana Gas Association and the Michigan Gas Association. There are now eighty-four affiliate members of the Institute, and nine affiliated associations now have representatives on the Board of Directors.

William E. McKay, *President.*
Geo. G. Ramsdell, *Secretary.*

The President: You have heard the report of the Board of Directors. What is your pleasure?

Mr. A. E. Forstall: Mr. President, I move it be accepted and spread on the minutes.

(The motion prevailed.)

The President: The next business is the report of the Secretary and Treasurer.

The Secretary: Mr. President, the report of the Secretary and Treasurer, which embodies also the report of the Membership Committee, has been printed, and is in the hands of the various members, so that I presume there is no necessity for reading it.

REPORT OF THE SECRETARY AND TREASURER.

Report of Committee on Securing New Members.

The list of new members elected during the year has been as follows:

On the March ballot—		
Active	12	
Associate	5	
Junior	5	
		22
On the September ballot—		
Active	79	
Associate	11	
Junior	18	
		108
Total		130

Carroll Miller, *Chairman.*

March Ballot, 1916.

Active.

Alden, Charles Arthur, Assistant Auditor, Boston Consolidated Gas Company, 111 Devonshire St., Boston, Mass.

Baker, Frank J., Vice-President, Public Service Company of Northern Illinois, Room 1320, 72 West Adams St., Chicago, Ill.

Dodds, Caryl J., General Manager, Citizens' Light, Heat & Power Co., 5 East 8th St., Lawrence, Kansas.

Hays, Victor Alden, President, and Auditor for Receivers, Kansas Natural Gas Company, P. O. Box 465, Independence, Kansas.

Heckert, Oscar Harbaugh, Secretary and General Manager, York Gas Company, York, Pa.

Munroe, Charles A., Vice-President, Public Service Company of Northern Illinois, 1310 Edison Bldg., Chicago, Ill.

Nichols, Walter E., Superintendent, Northern Indiana Gas & Electric Co., Plymouth, Ind.

Nickerson, Harry Levin R., Assistant to Superintendent, New England Gas & Coke Co., Everett, Mass.

Raymond, Charles Abel, Assistant to Superintendent, New England Gas & Coke Co., Everett, Mass.

Reed, David A., Manager, Water & Light Dept., Division of Public Utilities, City of Duluth, Minn.

Weisser, Frank Ludwig, Superintendent Gas Dept., San Antonio Gas & Electric Co., 305 East Houston St., San Antonio, Texas.

Wilbur, Monroe Elmer, Auditor, Boston Consolidated Gas Company, 111 Devonshire St., Boston, Mass.

Associate.

Diffenderffer, Charles H., President, Blair-Parke Coal & Coke Co., Real Estate Trust Bldg., Philadelphia, Pa.

McBride, Russell Smith, Associate Chemist, Bureau of Standards, Washington, D. C.

Miller, Walter Edward, Division Engineer, Railroad Commission of Wisconsin, 1719 Madison St., Madison, Wis.

Smyser, Albert Ernest, Engineer of Refractories, H. Koppers Company, 511 Wood St., Pittsburgh, Pa.

Weber, Hans F., Operating Engineer, Didier-March Company, Perth Amboy, N. J.

Junior.

Anderson, Arthur Henry, Cadet Engineer, St. Paul Gas Light Co., 121 Iglehart St., St. Paul, Minn.

Baker, John Rea, Student Engineer, Haverhill Gas Light Co., 28 Washington Square, Haverhill, Mass.

Bond, Frederick Almon, Cadet Engineer, Philadelphia Suburban Gas & Electric Co., Coke Ovens, Chester, Pa.

Smythe, Charles W., Manufacturing Dept., Public Service Gas Co., 446 Market St., Newark, N. J.

Wood, William Maxwell, Local Manager, Pacific Power & Light Co., Lewiston, Idaho.

Transfers to Active.

Porter, Roland Goodwin, Engineer, Rockford Gas Light & Coke Co., Gas Works, Rockford, Ill.

Smith, Oliver Hobson, Assistant Superintendent, New Amsterdam Gas Company, Ravenswood Works, Long Island City, L. I., N. Y.

Whipple, Robert Hoadley, Assistant Engineer, American Gas Company, West Washington Square, Philadelphia, Pa.

White, William Morse, Superintendent Coke Oven Dept., Philadelphia Suburban Gas & Electric Co., Coke Ovens, Chester, Pa.

SEPTEMBER BALLOT, 1916.

Active.

Almert, Harold, Consulting Engineer, 209 S. La Salle St., Chicago, Ill.

Bartel, Emil Joseph, Supt. Meter Repair Dept., Brooklyn Union Gas Company, 62 Twelfth St., Brooklyn, N. Y.

Bigelow, William Russell, Chief Chemist, Coal Products Mfg. Co., Joliet, Ill.

Blanquier, Juan, Chief Engineer, Santiago Gas Co., San Miguel 72, Santiago, Chile.

Blossom, Francis, Member Firm, Sanderson & Porter (Engineers), 52 William St., New York, N. Y.

Boardman, Clark Clinton, Supt. of Distribution, Western United Gas & Electric Co., Aurora, Ill.

Brandli, Henry Edward, Treasurer and General Manager, Citizens' Gas, Electric & Heating Co., Mount Vernon, Ill.

Bratton, Samuel Connor, Commercial Manager, Portland Gas & Coke Co., 5th and Yamhill Sts., Portland, Ore.

Bulfin, John F., Auditor, Laclede Gas Light Co., 1017 Olive St., St. Louis, Mo.

Byrnes, P. V., President and General Manager, United Gas & Fuel Co., 72 James St., N., Hamilton, Ontario, Can.

Cardell, R. C., Manager, Billings Gas Co., Billings, Montana.

Carlson, Carl Ira, District Manager, Western United Gas & Electric Co., 642 N. Ashland Ave., La Grange, Ill.

Chase, Seth Killian, Statistician, Peoples Gas Light & Coke Co., 122 S. Michigan Ave., Chicago, Ill.

Choate, Robert R., Manager, Spokane Gas & Fuel Co., 25 Monroe St., Spokane, Wash.

Curry, George Herbert, Purchasing Agent, Laclede Gas Light Co., 11th and Olive Sts., St. Louis, Mo.

Curtin, J. M., Chief Clerk, Application Dept., Laclede Gas Light Co., 1017 Olive St., St. Louis, Mo.

Dawson, George H., General Supt., Gas Dept., Springfield Gas & Electric Co., 400 E. Monroe St., Springfield, Ill.

Denman, B. J., Asst. General Manager, United Light & Railways Co., 125 West Third St., Davenport, Iowa.

Dezendorf, Richard Lee, Supt. Meter & Stove Dept., New Amsterdam Gas Co., 405 East 42d St., New York, N. Y.

Dodd, George D., District Supt., Laclede Gas Light Co., 4650 Labadie Ave., St. Louis, Mo.

Edmund, Harvey William, Commercial Agent, Western United Gas & Electric Co., Aurora, Ill.

Farrar, Harry L., Engineer, Southern Illinois Gas Co., Marion, Ill.

Fleischhauer, Fred'k J., Assistant Engineer, Henry I. Lea, Consulting Gas Engineer, 1352 Peoples Gas Bldg., Chicago, Ill.

Garrity, Edward, District Manager, Western United Gas & Electric Co., 111 East Front St., Wheaton, Ill.

Goodnow, Albert C., General Supt. North Shore Gas Co., Waukegan, Ill.

Gray, Carroll E., Jr., Manager, Boise Gas Light & Coke Co., Boise, Idaho.

Harsh, J. E., General Manager, Salina Light, Power & Gas Co., Salina, Kansas.

Henderson, Curtis L., Chief Engineer, Hale Gas Company, Neodesha, Kansas.

Hodgson, Harry Ellsworth, Asst. to Supt., United Gas Improvement Co., Point Breeze Gas Works, Philadelphia, Pa.

Hopper, Thomas B., Supt. West Station, Washington Gas Light Co., 413 Tenth St., N. W., Washington, D. C.

Jefferis, Charles A., Gen'l Supt., Consumers Gas Company, 269 Front St., East Toronto, Ont., Canada.

Kister, Hannie J., Manager New Business, Los Angeles Gas & Electric Corporation, 645 S. Hill St., Los Angeles, Cal.

Knabe, Albert, Supt. in Distribution Dept., Laclede Gas Light Co., 1017 Olive St., St. Louis, Mo.

Learned, John G., Asst. to Vice-Prest., Public Service Co. of N. Ill., Room 1310, West Adams St., Chicago, Ill.

Lewis, William E., Vice-Prest., Utica Gas & Electric Co., 222 Genesee St., Utica, N. Y.

Lohmeyer, Harry Bernhard, Chief Efficiency Dept., Consolidated Gas, Electric Light & Power Co., Lexington & Liberty Sts., Baltimore, Md.

Lynch, Eugene P., Chief Clerk, Clearing House Division, Acct. Dept., Laclede Gas Light Co., 11th & Olive Sts., St. Louis, Mo.

Macdonald, Robert B., General Manager, Fort Dodge Gas & Electric Co., Fort Dodge, Iowa.

McArthur, John A., Secretary & Treasurer, Hartford City Gas Light Co., 565 Main St., Hartford, Conn.

McCleary, William, Supt., New York & Richmond Gas Co., 1314 New York Ave., Rosebank, S. I., N. Y.

McLeod, James E., Comptroller, Laclede Gas Light Co., 11th & Olive Sts., St. Louis, Mo.

Mange, J. I., President, Kentucky Public Service Co., 43 Exchange Place, New York, N. Y.

Meloney, Charles Wesley, Asst. Engr., Henry I. Lea, Consulting Gas Engineer, Peoples Gas Bldg., Chicago, Ill.

Mendez, Abner John, Supt's. Asst., Holder Distribution Dept., Brooklyn Union Gas Co., 176 Remsen St., Brooklyn, N. Y.

Montgomery, George A., Vice-President & General Manager, Lincoln Gas & Electric Light Co., Lincoln, Nebr.

Murdock, W. J., General Foreman, Coal Products Mfg. Co., Joliet, Ill.

Murphy, Wm. J., District Supt., Laclede Gas Light Co., 2655 Adams St., St. Louis, Mo.

Murray, Edward S., Supt., Inspection & Maintenance Dept., Laclede Gas Light Co., 4205 Flad Ave., St. Louis, Mo.

Nicholls, Charles J., Superintendent, Laclede Gas Light Co., 2801 Gravois Ave., St. Louis, Mo.

Noble, Jay A., Superintendent Gas Dept., Lockport Light, Heat & Power Co., 28 High St., Lockport, N. Y.

Owens, John Henry, Supt. of Underground Work, Western United Gas & Electric Co., 871 Highland Ave., Elgin, Ill.

Paterson, Albert B., General Manager, Meridian Light & Railway Co., Meridian, Miss.

Patterson, Fred'k H., Assistant Auditor, Rochester Railway & Light Co., 34 Clinton Ave., N., Rochester, N. Y.

Pease, Luther M., Manager, Peoples Lighting, Heating & Power Co., 16 Depot Square, Barre, Vt.

Pipkin, Humphrey H., General Foreman Distribution Dept., Laclede Gas Light Co., 2801 Gravois Ave., St. Louis, Mo.

Robinson, Frank Ellsworth, District Manager, Western United Gas & Electric Co., 36 Lincoln Way, Aurora, Ill.

Rogers, Linies Boswick, Superintendent, Lansing Fuel & Gas Co., Lansing, Mich.

Russell, Walter Marvin, Manager, Emporia Gas Co., Emporia, Kansas.

Savage, George W., Supt. of Distribution, Philadelphia Suburban Gas & Electric Co., Chester, Pa.

Schafer, Fred'k J., Supt. Southern California Gas Co., 609 Garland Bldg., Los Angeles, Cal.

Smith, Fred'k M., Supt. Distribution, Public Service Gas Co., 249 E. 4th St., Plainfield, N. J.

Stitzer, Ralph Bourquin, Superintendent, Spokane Gas & Fuel Co., Spokane, Wash.

Taylor, Edward Hamilton, Fuel & Gas Engineer, 645 Rookery Bldg., Chicago, Ill.

Terradell, William Francis, Supt. of Distribution, Public Service Gas Co., 61 Hamilton St., Somerville, N. J.

Tossell, Albert L., Supt. Application Dept., Peoples Gas Light & Coke Co., 1635 Peoples Gas Bldg., Chicago, Ill.

Vance, Samuel Miller, General Manager and Treasurer, Bristol Gas & Electric Co., 615 State St., Bristol, Va.-Tenn.

Vilven, Fred. W., District Manager, Western United Gas & Electric Co., Batavia, Ill.

Von Gemmingen-Hornberg, Wm. G., Supt. Mfg. Dept., Brockton Gas Light Co., 46 Centre St., Brockton, Mass.

Wallace, Cylon Wilson, General Manager, Niagara Light, Heat & Power Co., 16 Young St., Tonawanda, N. Y.

Way, Albert L., Supt. of Distribution, Public Service Gas Co., South Amboy, N. J.

Weeks, Harvey E., District Manager, Western United Gas & Electric Co., Joliet, Ill.

Wehrle, George, Asst. Supt., Gas Dept., Denver Gas & Electric Co., 900 Fifteenth St., Denver, Colo.

Wetlaufer, Ervin Hudson, Asst. Engr., Henry I. Lea, Consulting Gas Engineer, 1352 Peoples Gas Bldg., Chicago, Ill.

Wheeler, Hugh Flower, General Manager, Hattiesburg Traction Co., Hattiesburg, Miss.

Whitted, Thomas B., Mechanical Engineer, 1100 Realty Bldg., Charlotte, N. C.

Willien, Leon John, Jr., Chemical Engineer, Charles H. Tenney & Co., 201 Devonshire St., Boston, Mass.

Willett, William Marble, Assistant General Manager, Western United Gas & Electric Co., 341 Spruce St., Aurora, Ill.

Woolfolk, Wm. Gordon, Chicago Manager, Sanderson & Porter, Engineers, 72 West Adams St., Chicago, Ill.

Workman, D. M., District Manager, Western United Gas & Electric Co., Woodstock, Ill.

Associate.

Cavender, John H., Vice-President, Chicago Retort & Firebrick Co., 208 La Salle St., Chicago, Ill.

Davis, William Walley, Manager, Coke Oven Dept., By-Products Coke Corp., 1501 McCormick Bldg., Chicago, Ill.

Griffith, David M., Mechanical & Gas Engineer, Otto Coking Co., 6 Church St., New York, N. Y.

Hibbard, Robert Leonard, Asst. Manager and Gas Engineer, Riter-Conley Mfg. Company, Pittsburgh, Pa.

Lamb, F. Karl, Manager, Lamb Construction Co., Marion, Ill.

Lemke, Frank Alexander, General Manager, Secretary and Treasurer, Humphrey Company, Div. of Ruud Mfg. Co., Kalamazoo, Mich.

McKean, Norton, Asst. Supt., Nathaniel Tufts Meter Co., 455 Commercial St., Boston, Mass.

Miles, Eugene Carpenter, Editor, American Gas Light Journal, 42 Pine St., New York, N. Y.

Porter, Horace C., Chemical Engineer, H. Koppers Company, 511 Wood St., Pittsburgh, Pa.

Russell, Norman F. S., General Sales Manager, United States Cast Iron Pipe & Foundry Co., 1421 Chestnut St., Philadelphia, Pa.

Willson, S. Tully, General Manager, Improved Appliance Co., 455 Kent Ave., Brooklyn, N. Y.

Junior.

Battin, Henry Weston, Assistant to Superintendent, Public Service Gas Co., 446 Market St., Newark, N. J.

Baty, Frederick, Assistant Superintendent Works, Easton Gas and Electric Co., 212 N. Front St., Easton, Pa.

Dowley, Edwin, Inspector, Laclede Gas Light Co., 919-A., So. Taylor Ave., St. Louis, Mo.

Gardner, Ralph Russell, Engineer's Assistant, Old Colony Gas Co., Weymouth, Mass.

Howell, Francis Kitchell, Cadet Engineer, Coal Products Mfg. Co., Joliet, Ill.

Latham, Frank William, Superintendent, Alexandria Gas Works, 200 Prince St., Alexandria, Va.

Laudlaw, Samuel A., General Foreman, Fitting Dept., Laclede Gas Light Co., 1136 N. Kingshighway, St. Louis, Mo.

McElevey, James, General Fitter Foreman, Laclede Gas Light Co., 1136 N. Kingshighway, St. Louis, Mo.

Morrissey, James J., Chemist, Philadelphia Suburban Gas and Electric Co., Coke Ovens, Chester, Pa.

Nies, H. O., General Street Foreman, Distribution Dept., Laclede Gas Light Co., 1940 Louisiana Ave., St. Louis, Mo.

Rhodes, Lewis B., Jr., Assistant Superintendent, Henrico County Gas Co., 900 North Ave., Richmond, Va.

Saylor, Rayford Clark, Secretary, Hagerstown Light & Heat Co., 86 West Washington St., Hagerstown, Md.

See, Milton, Jr., Superintendent's Assistant, Brooklyn Union Gas Company, 556 Kent Ave., Brooklyn, N. Y.

Staniford, Robert Hutson, Superintendent's Assistant, Brooklyn Union Gas Company, 556 Kent Ave., Brooklyn, N. Y.

Stirzel, Jacob Wm., Jr., Cadet Engineer, United Gas Improvement Co., Point Breeze Gas Works, Philadelphia, Pa.

Swearingen, Henry Grady, Superintendent Distribution, Gas Dept., Evansville Public Service Co., 124 Upper Second St., Evansville, Ind.

White, Lester Marius, Assistant Engineer, Henry I. Lea, Consulting Gas Engineer, 4727 Drexel Blvd., Chicago, Ill.

Williams, Joseph A., Inspector of High Pressure Manholes and Valves, Laclede Gas Light Co., 1017 Olive St., St. Louis, Mo.

Transfer to Associate.

Grant, Albert W., Jr., Operating Dept., H. Koppers Company, 511 Wood St., Pittsburgh, Pa.

Transfers to Active.

Cheeseman, Clyde Edward, Superintendent's Assistant, Brooklyn Union Gas Co., 556 Kent Ave., Brooklyn, N. Y.

Field, Horace Hopkins, Engineer, Sanderson and Porter, 72 West Adams St., Chicago, Ill.

Greene, Raymond Lewis, Assistant Superintendent, Brooklyn Union Gas Co., 556 Kent Ave., Brooklyn, N. Y.

Harris, Alan H., Jr., Superintendent, Coal Products Mfg. Co., Joliet, Ill.

Killgore, James N., Engineer, Bergen Division, Public Service Gas Co., Hackensack, N. J.

Osborne, Willard B., General Manager, Lowell Gas Light Co., 46 Mansur St., Lowell, Mass.

MEMBERSHIP REPORT.

Total membership September 1, 1916		1,546
Gain by election	130	
Gain by reinstatement	2	
		132
Members deceased	14	
Members resigned	62	
Members dropped for non-payment of dues	34	
Members elected, but did not qualify	3	
		113
Junior Members transferred to Associate	1	
Junior Members transferred to Active	10	
		11

TREASURER'S REPORT.

CAPTAIN WM. E. MCKAY, *President*, September 29, 1916.
American Gas Institute,
29 West 39th St., New York City.

DEAR SIR:

I have the honor to report that I have audited the accounts of the American Gas Institute for the period of twelve months ended August 31, 1916, and have found the same to be correct.

I verified that the receipts for the year as shown by the cash book had been deposited in the bank; that all disbursements have been duly authorized and were covered by properly approved vouchers; and further tested the correctness of the payments by examining certain of the venders' invoices. A certificate was obtained from the bank confirming the balance on deposit as shown by your records as of August 31, 1916. The petty cash on hand was counted and found to be correct.

Very truly yours,

CHESTER P. CHILD, *Certified Public Accountant.*

SCHEDULE "A."—Statement of Assets and Liabilities.

As of August 31, 1916.

Assets.

Cash in bank and on hand				$ 3,325.00
Unpaid dues:	1914	1915	1916	
	$320.00	$970.00	$2,922.50	
Less reserve	320.00	320.00	480.00	
		650.00	2,442.50	3,092.50
Unpaid subscriptions and sales				467.55
Inventory of publications and merchandise on hand (book value)				13,393.37
Film (book value)				300.00
Furniture and fixtures (purchased in 1916)				240.33
Total assets				$20,818.75

Liabilities.

Accounts payable		$ 281.24
Dues received in advance		130.00
Liability for unearned subscriptions:		
Gas Institute News	$1,112.22	
Abstracts	515.69	
		1,627.91
Surplus:		
Balance per books of September 1, 1915	$12,352.31	
Net income for year (Schedule "B")	6,427.29	
Balance August 31, 1916		18,779.60
		$20,818.75

SCHEDULE "B."—Statement of Income and Expenses.

For the Period of Twelve Months Ended August 31, 1916.

Income.

Dues: Active		$16,845.00	
Associate		3,330.00	
Junior		1,462.50	
Affiliate		168.00	
		21,805.50	
Less: Reserve for delinquent dues	$480.00		
Remitted for resignations	668.75		
Remitted for deaths	112.50		
		1,261.25	
			$20,544.25
Initiation fees			490.00
Income from sales, etc. (Schedule "C")			1,902.19
Deficiency fund			380.00
Collective Gas Exhibit surplus			155.77
Badges			22.25
Interest on bank balances			219.45
Miscellaneous income			6.25
Total income			$23,729.16

Expenses.

Office expenses:		
Salaries	$6,346.61	
Rent of office and storeroom	1,980.72	
Printing and supplies	462.98	
Postage	289.09	
Telephone and telegraph	150.17	
Expressage and parcel post	124.57	
Moving expense	77.99	
Insurance	50.20	
Library	28.00	
Miscellaneous	289.99	
		$ 9,800.32
Meetings and Committees:		
Directors meetings	$614.05	
Committee expenses	425.80	
Meeting expenses	318.65	
Technical Committee expenses	271.77	
		1,630.27
Appropriation to Educational Fund		500.00
Dues to other Societies		60.00
Members: News	$1,167.86	
Proceedings	3,504.42	
		4,672.28
Total expenses		$16.662.87
Net income for year		$ 7,057.29
Deduct: Dues for prior years:		
Reserve for delinquents	$640.00	
Dues remitted, resigned	100.00	
Dues remitted, deaths	30.00	
	770.00	
Less, collections applying to prior years	140.00	
		630.00
Transferred to surplus		$ 6,427.29

SCHEDULE "C."—DETAILS OF INCOME FROM SALES, ETC.

	Sales	Cost of sales	Profit
Gas Institute News	$2,734.68	$1,601.11	$1,133.57
Bulletin of Abstracts	1,587.64	1,405.48	182.16
Proceedings	401.00	279.72	121.28
Advance papers	313.55	175.39	138.16
Pipe standards	47.93	8.40	39.53
Uniform System of Accounting	114.50	33.99	80.51
Merchandise	621.26	575.98	45.28
Film	180.00	18.30	161.70
Total	$6,000.56	$4,098.37	$1,902.19

STATEMENT OF OUTSTANDING ACCOUNTS.

Delinquents for one year's dues, ending August 31, 1916.				
Active,	82 @ $15.00		$1,230.00	
	1 @ 5.00	(Balance)	5.00	
Associate,	9 @ 15.00		135.00	
Junior,	19 @ 7.50		142.50	
				$1,512.50
Delinquent for two year's dues, 1916 and 1915.				
Active,	49 @ $25.00		$1,225.00	
	1 @ 10.00	(1915 dues)	10.00	
Associate,	3 @ 25.00		75.00	
Junior,	22 @ 7.50		275.00	
				$1,585.00
Delinquent for three year's dues, 1916, 1915 and 1914.				
Active,	27 @ $35.00		$ 945.00	
Associate,	1 @ 35.00		35.00	
Junior,	8 @ 17.50		140.00	
				$1,120.00
				$4,217.50
Owing for Bulletin of Abstracts				65.00
Unpaid miscellaneous sales				82.05
Unpaid Proceedings subscriptions				112.50
Owing for News subscriptions				208.00
				$4,685.05
Cash received on above Outstanding Accounts since September 1.				
Cash received on Abstract subscriptions			$ 5.00	
Cash received on Proceedings subscriptions			45.00	
Cash received on News subscriptions			200.00	
Cash received on miscellaneous merchandise sales			45.43	
Cash received on outstanding dues			245.00	
				540.43
				$4,144.62

SECRETARY'S REPORT ON PROCEEDINGS.

Volumes I, II, III, IV, V, VI, and VII.	
In stock September 1, 1915	1,612
Sent out and sold during year	22
In stock September 1, 1916	1,590
Volume VIII.	
In stock September 1, 1915	404
Sent out and sold during year	7
In stock September 1, 1916	397

Volume IX.	
In stock September 1, 1915	355
Sent out and sold during year	19
In stock September 1, 1916	336
Volume X.	
In stock	454
Sent out and sold during year	14
In stock September 1, 1916	440
Ten Year Index.	
In stock	600
Sent out and sold during year	16
In stock September 1, 1916	584

Badge Report.

On hand September 1, 1914	118
Sold during the year	15
On hand September 1, 1915	103
Bought	2
	105
Sold during the year	7
On hand September 1, 1916	98

The President: The report of the Secretary and Treasurer is before the meeting. What is your pleasure?

Mr. G. H. Waring: I move that the report be accepted.

(The motion was duly seconded and carried.)

The President: The report of the Committee on Election of New Members.

Mr. Carroll Miller (Aurora, Ill.): It seems I have two reports to make. I have no report for this committee except what the Secretary has given you. But I might say this: That in reviewing the membership of this Association, of all the gas companies in this country, I do not believe there were over 40 per cent. represented individually. Many of these companies are controlled by parent companies, which are represented; but I wish to emphasize that individually there were only about 40 per cent. I have been assisted very ably by the other members of this committee—I think there are about eighty. They did very good work, for which I wish to thank them now. We secured one hundred and thirty new members, but from very few new companies. For instance, one company put in fifteen or twenty members. I think steps should be taken to secure at least one member from each gas company.

THE PRESIDENT: We are indebted to Mr. Miller and his committee for the excellent and successful work that they have prosecuted on behalf of the Institute in the past year.

Co-ordinate with this subject, it will now be opportune to receive the report of the Affiliation Committee. The Chairman, I think, is not here, and in his absence Mr. Barnes will present the report of the committee.

MR. A. M. BARNES (Cambridge, Mass.): Mr. Dutton, the Chairman of the Committee on Affiliation, has prepared this report, and as he is unable to be present, the duty of reading it to you falls upon me.

REPORT OF AFFILIATION COMMITTEE OF THE AMERICAN GAS INSTITUTE.

Chicago, Ill., October 17, 1916.

Report of Affiliation Committee,
To American Gas Institute.

GENTLEMEN:

Your Committee has continued to present the subject of affiliation to various State and District Associations, and favorable consideration and action has been secured in many instances during the past year.

SOUTHERN GAS ASSOCIATION.

In our report last year, information was furnished that the Southern Gas Association had decided to affiliate, but that the affiliation agreements had not been executed at the time of our Annual Meeting.

These agreements were executed early in the present Institute year.

WISCONSIN GAS ASSOCIATION.

The Wisconsin Gas Association during the year executed a new affiliation agreement under the 1915 revised Constitution and By-Laws of the Gas Institute, and by the payment of dues of two dollars ($2.00) for each of their members who were not already members, have provided them Affiliate Memberships in the Institute.

NEW ENGLAND ASSOCIATION OF GAS ENGINEERS.

The New England Association of Gas Engineers, the oldest gas association in America, acted favorably at their Annual Meeting, and executed affiliation agreements with the Institute early in 1916. This Association covers in its membership the gas interests within the States of Maine, New Hampshire, Vermont, Massachusetts, Rhode Island and Connecticut.

PENNSYLVANIA GAS ASSOCIATION.

The Pennsylvania Gas Association has taken advantage of the opportunities of affiliation, by paying the annual dues of two dollars ($2.00) for all the members of their Association who were not members of the Institute—thus providing all their members some form of membership in the Gas Institute.

SOUTHWESTERN ELECTRICAL AND GAS ASSOCIATION.

The subject of affiliation was brought to the attention of the Southwestern Electrical and Gas Association at their 1916 sessions, but in view of the fact that the Association membership is largely made up of those representing electric light, power, and electric railway business, it was deemed advisable not to affiliate with the Association at this time.

The hope was expressed, however, that in the future some plan might be arranged whereby the gas interests of the Association might be able to consider the matter favorably, independent of the Association.

INDIANA GAS ASSOCIATION.

During the 1916 annual session of the Indiana Gas Association the matter of affiliation was presented and favorably considered. The matter was referred to the Directors of the Association with authority to act.

At a meeting of their Board of Directors on September 20, it was unanimously voted to affiliate with the Gas Institute, and the affiliation agreements have been prepared and executed.

MICHIGAN GAS ASSOCIATION.

The subject of affiliation was presented to this Association to consider at their meeting held in September, 1916. Favorable action was taken, and the Directors were authorized to complete details. Affiliation agreements with this Association have been prepared and executed.

PACIFIC COAST GAS ASSOCIATION.

The subject of affiliation was also presented to this Association at their Annual Meeting, and we hope to receive favorable report in due time.

CANADIAN GAS ASSOCIATION.

We felt it within the jurisdiction of our Committee to approach the Canadian Gas Association in the matter of affiliation, and this was done at their meeting in Quebec on August 17, 1916.

The subject was favorably received by the Association in their sessions, and the matter referred to their Executive Committee for action. We have since prepared affiliation agreements for this Association, and the impression received from their officials is that favorable action will be taken by them at their next meeting, to be held in a few months.

SUMMARY.

The several gas associations mentioned in this report, in addition to the New Jersey State Gas Association, Iowa District Gas Association, and the Illinois Gas Association, all of which were previously affiliated with the Institute, all bear evidence to the growing sentiment looking to active co-operation among the gas interests of the various sections of our country.

This leaves only two State Associations not affiliated—with the exception of the Pacific slope.

By the representation of each of these Associations, through a Director of the Board of Managers of the Institute they are enabled to keep in touch with its activities.

It is a hopeful sign pointing to a realization of the possibilities of securing a standardization of regulations, etc., in our work.

The work of this Committee during the coming year should be along the lines of seeking the co-operation of the State and District Associations by encouraging all of their members to take at least an Affiliate Membership in the American Gas Institute.

This will enable them to receive the Gas Institute *News* monthly, keeping them advised of the activities of the gas industry.

During the year a form of certificate for the new Affiliate Membership has been prepared and issued to two Associations having all their members affiliated.

Respectfully submitted,
A. M. Barnes,
Cambridge, Mass.;
E. D. Brewer,
Atlanta, Ga.;
F. A. Cressey, Jr.,
Modesto, Cal.;
J. W. Dunbar,
New Albany, Ind.;
L. R. Dutton, *Chairman*.
Wyncote, Pa.,

The President: The report of the Committee on Affiliation is before the meeting.

Mr. E. H. Earnshaw (Newark, N. J.): I move that the report of the Committee be accepted and spread upon the minutes; and I also think that the thanks of the Institute should be presented to this Committee for this very valuable work. It is a very important work, and its benefits to the Institute are such that I think they are very much entitled to a vote of thanks. I move that such be given.

(The motion was duly seconded and carried.)

The President: Mr. Russell will take the chair. You have already heard in the report of your Board of Directors that Mr. Russell's absence from the meeting was occasioned by illness. His presence is occasioned by his recovery. (Applause.)

(Mr. Herman Russell presided as Temporary Chairman.)

The next order of business, I believe, is the President's Address.

ADDRESS OF PRESIDENT WILLIAM E. McKAY.

President McKay: The American Gas Institute was formed and held its first annual meeting in this city in 1906. Then the world was at peace and at work on the promotion of civil welfare, the advancement of industrial efficiency, and the conservation of natural resources and human life. Now the world is at war, individual and local interests are completely subordinated to national requirements, military necessities have pre-emption, and for many years there has endured a colossal and unparalleled wastage of property and human life. The diversion of national activities from the highways of peace into the channels of war, and the cumulative effects of devastating conflict have been manifest not only in the states at war but everywhere else throughout the world. Like an earthquake or a conflagration, this war is reducing the world's assets, and a large part of the new burden must be borne by the neutral countries. Each day brings new cause for the readjustment of our outlook made necessary by the progressive alteration of basic conditions; and not even the restoration of peace will allow us to re-establish the ante-bellum circumstances of labor and industry.

The experience of the war has shown that gas properties are a natural asset of prime military value. Modern warfare requires enormous quantities of high explosives; as they cannot be stored in large quantities, the capacity to manufacture must exceed the possible average daily consumption. Gun-cotton and smokeless powder are made by nitrifying cotton; all high explosives are made by nitrifying toluol, phenol, and other by-products of gas manufacture; the nitrifying agent, nitric acid, can be readily made from ammonia. It is stated that in England alone the present daily make of nitrate of ammonia is 600,000 pounds. Many hundreds of European gas companies are now recovering benzol and toluol for use in high explosives. To meet the extraordinary demand, by-product coke oven plants in the United States will this year produce many millions of gallons of these products.

It is no longer sufficient to describe the process of gas making as the destructive distillation of coal; on the contrary, it is a process of conservation that places us in the van-guard of this praiseworthy advancement. Your attention is directed to two notable editorials written by Past Presidents of the Institute, and published in the Gas Institute *News* of August and September, on "Conservation in the Gas Industry," and "Position of the Gas Industry in the Nation's Scheme for Preparedness;" the authors respectively recommend the appointment of a Committee on Conservation, and that proper representation be made by the Institute before the Federal officials who have to decide upon the $20,000,000 government plant for the production of nitrates for munitions of war,—the plant to be useful in the manufacture of fertilizers in times of peace. The Naval Advisory Board have already collected the information as to gas and coke plants and products; and it is incumbent upon the Institute to demonstrate the potential economy of fully utilizing these existing and operative manufacturing plants. In September, the Directors requested the Public Relations Committee to represent the Institute before the officials having authority in the establishment of the proposed artificial nitrate factory. In the field of agriculture our ammonia is now serving the needs of peace; its conversion into nitric acid to serve the needs of war is facile, reasonable and economical.

At the Richmond meeting, in 1913, the President stated: "The most important condition facing the gas industry to-day is the increasing cost of materials and supplies, including materials for enrichment." This condition, with the inclusion of increasing costs for capital and for labor, is even more pressing in 1916. In Italy, in France, in England, in Germany, labor and coal are scant, the selling prices of gas have been much increased, extensions and construction have been deferred because money and men have been used in more urgent work, and women have taken the place of men in the works as well as in the offices; these occurrences foreshadowed their counterpart in countries at peace. On all sides we already hear lament over the scarcity of labor; not only are there less workmen, but there is an observed decrease in the efficiency of labor; wages are more and work is less. With smaller outputs the mine prices of coal have greatly advanced. The depredations of submarine warfare, and the heavy export trade, have so reduced available tonnage as almost to triple the cost of coastwise water transportation; rail rates are scheduled to go higher. Other and similar causes have in like manner increased the cost of machinery, apparatus, oils, and everything used in our manufacture. Even with higher costs, raw materials are not everywhere abundantly procurable. Modern government costs more, and the multiplication of statutes does not facilitate business. Gas is not yet in step with the upward march of the cost of living; for a hundred years we have successfully striven to give better service and ever at lower prices; we may need to readjust our perspective, and to unite our efforts for the maintenance of satisfactory service at higher prices for our prime product. It is the time for better and closer co-operation with each other and with our customers, among our companies, between our associations, and with the state and federal regulating bodies.

In the ten years of its life the work of the Institute has abundantly justified the expectations of its founders. Its enduring contributions to the helpful knowledge of the industry have been large in volume and high in value. The conceded excellence of the technical work of the Institute was a continuation of the accomplishment of the Associations from which it was formed; but the establishment of the Public Relations Committee was a prophecy of which the event is full of honor. The serviceable activity of this Committee has grown prodigiously, especially since the Committee became permanently constituted, with a secretarial member whose technical and professional qualifications are eminent. In the Technical Committee there has been an advantage from rotation in office; but in the Public Relations Committee the conspicuous advantage has resulted from the continuity of voluntary service which has steadily widened the sphere and elevated the plane of the authoritative influence of the American Gas Institute in Public Relations.

The original program contemplated co-operation with state and other associations by virtue of mutuality of technical interests, but the energizing basis of real co-operation has developed from Public Relations, as is evidenced by the history of affiliation. In 1908, the Illinois, Wisconsin and Iowa Associations affiliated with the Institute; Pennsylvania in 1912; since September, 1915, the Southern, the New Jersey and the New England, Indiana and Michigan Associations have affiliated, and other associations look towards affirmative action.

The formation of the associations and the establishment of educational facilities proceeds apace;—The Texas Association, the By-product Coke Producers, the American Gas Industries; a Gas Research fellowship at the University of Illinois, a course in Coal Gas By-products Recovery at Johns Hopkins University, and by the Massachusetts Institute of Technology a branch school of instruction in Chemical Engineering as related to gas. In February, the Directors adopted a resolution expressing appreciation of the work being done by colleges and universities in establishing courses and laboratories for the study of gas engineering. We need to co-operate effectively with every other association and with every activity that has the welfare of the gas business as its object.

Since 1906, the income of the Institute has doubled. The membership has increased from 1,215 in 1907, to 1,525 in 1915, a total addition in eight years of 310 members; in this same period the Institute membership from the six eastern states of Massachusetts, Rhode Island, Connecticut, New York, New Jersey and Pennsylvania, increased from 564 to

874, or by 310; while the seven states of Ohio, Indiana, Illinois, Michigan, Wisconsin, Iowa and Missouri decreased from 401 to 346, or by 55 members; it is a favorable augury that in 1916 55 new members have been elected from these seven states. We earnestly desire the numerical and financial support that are essential to the broadest success of the Institute in its aim to be everywhere and in every way helpful to our country. Notwithstanding the large increase in annual dues, this year closes with a net gain of 102 members; this can be regarded as a satisfactory endorsement of the policy adopted for increasing our income through raising the dues, and testified approval of the work already accomplished, and betokens confidence in the future work of the Institute.

One of the qualifications for membership concerns employment, usually in a company whose prime or by-product is gas. These companies and our own members have generously assisted the professional and practical work of the Institute, defraying the expenses of investigation, compilation and research subsequently contributed to our PROCEEDINGS, and carrying the charges of attendance and participation in committee work involving expenditures that would otherwise demand appropriations of the Institute. It is seldom that support in men and money have not been promptly forthcoming for work where there is agreement as to need and imminence.

The scientific preparation and probationary experience that have become preferential in the engineering branches can, with equal efficacy, be applied to the sales departments, where, when joined to the art of salesmanship it will, like steel in concrete, fix the foundation and stabilize the structure, and will insure and accelerate satisfying returns.

Experience has demonstrated that the composition of our membership, and the effective exercise of our functions has established and can maintain our prestige; and that the American Gas Institute can and will continue to be accredited as the premier basis of authoritative reference in the affairs of our vocation.

Many of the members know the Institute only through the monthly *News* and the Annual Meeting. The reports of the Board of Directors and of the General Committees set forth the principal business transacted during the year. To those who have participated in the work of the Committees on Arrangements, Technical Programs, and Public Relations, we are each year indebted in a greater degree; in its own office and through its affiliations the Institute work is steadily growing in volume and in worth. The office work of the Institute has increased so much that this year, finances permitting, the Directors appointed an Assistant Secretary. The new quarters of the Institute have satisfactorily provided convenient accommodations, and have been used with greater frequency for meetings of the Directors and of various committees. The expansion of committee work is indicative of more general participation by members, and of constantly improving accomplishment.

The census report for 1914 shows, for five years, 35 per cent. increase in the sales of gas (exclusive of coke oven gas); the inevitable growth of our business is abundant cause for felicitious encouragement. The young men who, in large numbers, are now aligning themselves in our ranks face a future full of promise of exceptional opportunity and compensating success; we welcome them heartily, confident that their energy and ability will support and promote the morale and the material prosperity of our profession.

It is appropriate to manifest our esteem and respect for the fourteen members whom we have lost by death. Benjamin W. Perkins, as President of the Ohio Association, became the first President of the Institute in 1906, and served in that capacity at the initial meeting in Chicago ten years ago. In the list of those whose work is finished are Sir Corbet Woodall, an honorary member, and D. S. Knauss, a junior member; the former after a long life full of achievement and honors, the latter at the threshold of a career which held a hopeful assurance of high attainment.

Those who were in attendance at the San Francisco meeting well remember the cordial hospitality and the pervasive enthusiasm of our hosts, the proximity of the Exposition and the success of the Gas Congress. My involuntary absence from that memorable convention impels me now to avail myself of this opportunity to express to the members of the Institute my appreciative acknowledgement of the honor and the privilege of presiding at this, the eleventh annual meeting.

THE TEMPORARY CHAIRMAN: I am sure we all enjoyed listening to the admirable address from our President.

In accordance with custom it is my duty to appoint a Committee on President's Address. I appoint on that Committee C. M. Cohn, J. W. Dunbar and R. B. Brown.

THE PRESIDENT: The next business is the report of the Trustees' Gas Educational Fund.

EIGHTEENTH ANNUAL REPORT OF THE TRUSTEES GAS EDUCATIONAL FUND TO THE SUBSCRIBERS TO THE FUND.

To the Subscribers to the Trustees Gas Educational Fund:

GENTLEMEN: The Trustees appointed at the Twenty-sixth Annual Meeting of the American Gas Light Association, held October 17, 1898, to administer the Educational Fund formed by your subscriptions, submit the following report as to the work done from October 1, 1915, to September 30, 1916.

The membership in the class on September 30, 1916, shown by the report of the Secretary, is practically the same as last year.

Seventy copies of the "Catechism of Central Station Gas Engineering in the United States" have been sold during the year, leaving on hand one leather-bound and twenty cloth-bound copies. This supply will probably be exhausted within a few months, and there is under consideration the question of revising the matter and publishing a second edition. As shown by the report of the Treasurer, the proceeds of the sales up to September 30, 1916, have exceeded the expenses of publication and advertising by $3,390.86. Of this amount $2,200 has been added to the Surplus Fund.

During the year thirteen members of the Section of 1916 finished their course and their connection with the class ceased. It has been decided that the members of the class who completed the course shall receive a certificate to that effect and these certificates will soon be ready to send out. They will be sent to all the students who have completed the course during the whole time of the existence of the class as far as the present addresses of these students are known.

The Section of 1919 started work on January 1, 1916, with a membership of twenty-eight, which has been increased to thirty-nine, as the number of new members coming in has exceeded that of those who resigned or were dropped for not sending in answers to the questions.

The number of members in each section at the beginning of the year, with the changes that have taken place, and the names of the members of the class who have completed the course during the year, are shown in detail on the Secretary's Report which is appended.

The Section of 1917 contains twenty members, the Section of 1918 fourteen, and the Section of 1919 thirty-nine, making the total membership in the class seventy-three.

The card index of the principal articles published in the *American Gas Light Journal, Gas Age* and the *Journal of Gas Lighting* has been kept up during the year.

The Treasurer's Report, which is appended, shows the total amount of subscriptions to date, the available income and expenses for the year, a summary of the cash account and the statement of the amount of the surplus fund and the securities in which it has been invested.

The Surplus Fund, now amounting to $21,889.73, is made up of a contribution of $2,000.00, of subscriptions paid in advance of the time when they are due, of unexpended balances, of interest received on investments, and of a portion of the profit on the publication of "Catechism of Central Station Gas Engineering in the United States."

Respectfully submitted,
TRUSTEES GAS EDUCATIONAL FUND,
WALTON CLARK, *Chairman,*
ALFRED E. FORSTALL, *Secretary.*

SECRETARY'S REPORT, SEPT. 30, 1916.

	Section of 1916	Section of 1917	Section of 1918	Section of 1919	Total
Members enrolled Oct. 1, 1915	15	35	27		77
Entered class Jan. 1, 1916....				28	28
Additions to class since Jan. 1, 1916		1	3	39	43
	15	36	30	67	148
Resigned since Oct. 1, 1915..	1	2		5	8
Dropped for non-receipt of answers since Oct. 1, 1915.	1	14	16	23	54
Finished course since Oct. 1, 1915	13				13
	15	16	16	28	75
Total enrollment Sept. 30, 1916		20	14	39	73

Applications on file for admission to class January 1, 1917............7

NAMES OF STUDENTS WHO COMPLETED THE THREE YEARS' COURSE WITH SECTION OF 1916.

Robert R. Barr, Baltimore, Md.
Wm. A. Bradley, Mamaroneck, N. Y.
J. P. Connolly, Charleston, S. C.
Chester W. Flanders, Washington, D. C.
Wm. H. Magill, Jr., Philadelphia, Pa.
Thomas G. Meara, Hammond, Ind.
George J. Munson, Waterbury, Conn.
Fred. J. Newberth, Pontiac, Mich.
Caldwell B. Spates, Yonkers, N. Y.
George S. Voorhees, Detroit, Mich.
H. Sigurd Walter, Baltimore, Md.
John E. Welsch, Peekskill, N. Y.
C. Edgar Wood, Hammond, Ind.

REPORT OF ALEXANDER C. HUMPHREYS, TREASURER, FOR THE FISCAL YEAR ENDING SEPT. 30, 1916.

Condition of Subscriptions.

		For Year 1915-1916
Total subscriptions for third five-year period holding over	$ 770.00	$ 440.00
Total new subscriptions for fourth five-year period Sept. 30, 1915	18,675.00	3,735.00
Total subscriptions received since that date	831.00	167.00
	$20,276.00	$4,342.00
Reduction in subscription	15.00	5.00
	$20,261.00	$4,337.00
Received from subscribers since Sept. 30, 1915	$4,167.00	
Payments not applicable to year	1,670.00	
Total paid in by subscribers since Sept. 30, 1915, and available for year	$2,497.00	
Paid in previous to current year on account of 1915-1916 instalments	1,780.00	
Total paid in by subscribers available for this year	$4,277.00	
Still to be paid for this year	60.00	
Total amount available for year		$4,337.00

Statement of Income and Expenses.

Total amount available for year		$4,337.00

Expenses.

Secretary's salary	$2,750.00	
Clerical help	250.00	
Office rent	300.00	
Printing, stationery, postage, etc	547.04	
Periodicals and binding	23.23	
Fire insurance on books	16.75	
Total expenses paid to Oct. 1, 1916	$3,887.02	
Add for expenses incurred but unpaid	42.25	
Total expenses for year		3,929.27
Balance		$407.73
Depreciation on furniture		9.00
Total balance on year's operation		$398.73

Cash Account.

Received from subscribers since Sept. 30, 1915	$4,167.00	
Interest on securities owned as scheduled under heading "Surplus Fund"	885.00	
Interest on deposits in bank	99.39	
Received for copies of "Catechism of Central Station Gas Engineering in the United States," including carrying charges	284.76	
Total receipts for year	$5,436.15	
Cash balance from last year	5,374.97	
Total to account for		$10,811.12
Expenses for the year paid	$3,887.02	
Four Dominion of Canada government bonds	3,953.89	
Total paid out		7,840.91
Balance		$2,970.21
Balance in Columbia Trust Co., as per statement.	$548.87	
Balance in Guaranty Trust Co., as per statement, less checks unpaid	2,405.09	
Cash on hand	16.25	
		$2,970.21

Publication Account.

Total receipts to Sept. 30, 1915	$6,350.35	
Received for copies of "Catechism of Central Station Gas Engineering," including carrying charges, since Sept. 30, 1915	284.76	
Total receipts to date	$6,635.11	
Due for books delivered but not yet paid for	32.00	
		$6,667.11
Total expenses to date		3,276.25
Balance		$3,390.86

Of this amount $2,200 has been transferred to Surplus Fund.

Surplus Fund and Investment.

Amount paid in by subscribers in advance	$2,845.00	
Amount paid in by subscribers to Surplus Fund	2,000.00	
Net amount of unexpended balances previously reported	6,162.67	
Unexpended balance 1914-1915	431.30	
Interest on bonds to date	7,277.22	
Interest on deposits in bank	973.54	
Transferred from Publication Account	2,200.00	
		$21,889.73

Already Invested.

$2,000 Binghamton Gas Works, 1st Mortgage, 5% Bonds	$1,930.00	
1,500 Atchison, Topeka & Santa Fe R. R. General Mortgage 4% Bonds	1,513.75	
2,000 Omaha Gas Company, 1st Mortgage 5% Bonds	2,000.00	
1,500 New Gas Light Co. of Janesville, 1st Mortgage 5% Bonds (guaranteed by the United Gas Improvement Co.)	1,500.00	
5,000 Syracuse Light & Power Co., Collateral Trust Sinking Fund 5% Bonds	3,831.25	
2,000 Welsbach Company 5% Collateral Trust Mortgage Bonds	1,826.94	
2,000 Detroit & Suburban Gas Company, 1st Mortgage 5% Bonds	1,777.50	
1,000 San Antonio Traction Co. 5% Bonds	1,995.00	
1,000 San Antonio Gas & Elec. Co. 5% Bonds		
4,000 Dominion of Canada 5% Gov't Bonds	3,953.89	
Furniture	81.03	
		20,409.36
Balance		$1,480.37

NEW YORK, OCT. 13, 1916.

The undersigned has this day examined the books and accounts of Alexander C. Humphreys, Treasurer, for the year ending September 30, 1916, and has found the same to be correct, and the above balance of $2,970.21 to be on hand and in the bank.

C. N. JELLIFFE,
Auditor.

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MR. A. E. FORSTALL (New York): Mr. President and members of the Association, this report, while listed as a report of a committee, is really a report to the American Gas Institute as a subscriber to the Educational Fund. Printed copies can be had by those who are interested in this subject, at the table outside of this room where the papers are placed. I will not read the full report, but call attention to some of its salient features.

One of the matters under consideration by the Trustees is the publication of a revised, second edition of the "Catechism of Central Station Gas Engineering." For the last few years the demand for that publication has been very small, and it is a serious question whether the printing of a second edition would be warranted. If there is to be any general demand for it the Trustees would like to be informed of it, as it might influence them in their action.

The practical class continues of the same size, running about eighty members, and the subscriptions by which the work of the class is carried on continue at practically the same amount. The surplus fund which the Trustees have been building up with the idea of making the work self-supporting so that it would not be necessary to ask for subscriptions every five years, is growing steadily, chiefly through the income from the securities in which it is invested. This income amounts at present to $1,035.00 per year.

Another matter which will be of interest to the members of the class who completed the course in the past, is that after much deliberation, and I suppose to the members of the class rather annoying deliberation, the Trustees have decided to issue certificates to those who have completed the course, and those certificates will be issued to every one from the very beginning of the class, provided we know their addresses. We would like to have the former members of the class whose membership dates back quite a number of years, to send in the addresses so that we can be certain they will get their certificates.

THE PRESIDENT: The next business is the report of the Nominating Committee.

MR. CARROLL MILLER: The nominating Committee of the American Gas Institute submits the following report:

For President:

Alfred E. Forstall, of New York.

Vice-Presidents,

Accounting Section:

William McClellan, of New York.

Chemical Section:
C. C. Tutwiler, of Philadelphia.
Distribution Section:
J. W. Batten, of Detroit, Mich.
Illumination Section:
J. Arnold Norcross, of New Haven, Conn.
Manufacturing Section:
George B. Evans, of St. Louis.

Directors:
H. C. Abell, New York City.
A. M. Barnes, Cambridge, Mass.
O. B. Evans, Philadelphia.
H. M. Papst, Portland, Ore.
Theodore V. Purcell, Chicago.

Secretary and Treasurer:
Geo. G. Ramsdell.

Respectfully submitted,

V. F. DEWEY, *Chairman,*
JOHN WILLIAMSON,
WALTON FORSTALL,
H. B. MCLEAN,
CARROLL MILLER,
Nominating Committee.

THE PRESIDENT: I will appoint as tellers of election Col. E. G. Pratt, D. J. Collins and J. T. Lynn.

Gentlemen, the report of the Nominating Committee is now before you.

MR. J. M. MOREHEAD (Chicago): I move the report of the Nominating Committee be accepted, and the Secretary instructed to cast the vote of the Institute for the names as read by the Chairman of the Nominating Committee.

(The motion was duly seconded.)

THE PRESIDENT: Is there any objection? The motion has been made and seconded that the Secretary be instructed to cast the ballot of the Institute for the names as reported by the Nominating Committee. Those in favor will please say "aye."

(The motion prevailed.)

COL. E. G. PRATT: Mr. President and gentlemen: I take pleasure in reporting that the ballot has been cast by the Secretary for the nominations as given in the report of the Committee.

THE PRESIDENT: Mr. Brown, the result of the election has been announced. Will you kindly conduct the president-elect, Mr. Forstall, to the platform.

MR. ALFRED E. FORSTALL: Mr. President and fellow-members of the American Gas Institute: No one who has been closely connected with Association work can fail to appreciate very deeply the honor of the selection to what I consider to be the highest position in the gift of the gas industry. At the same time, having been associated with Association work for a great many years I also appreciate probably more deeply than any one else here could, the great responsibility that this honor carries with it, and I only hope that I will be able to live up to and carry that responsibility successfully through the coming year.

It is perhaps a fitting coincidence that this honor should have been conferred in this city in which I first became continuously connected with the gas business, thirty-two years ago. At that time—although they say that every American carries—not in his knapsack, but in his inside coat pocket—the commission of president, I did not think that that commission was coming to me.

I cannot carry the responsibility of the office successfully, however, unless I have the close and cordial co-operation of every member of the Institute, and I hope that those on whom I call will respond to the call and give me the best aid that they can. (Applause.)

THE PRESIDENT: Mr. McClellan is not here. I will call on Mr. Tutwiler.

MR. C. C. TUTWILER (Philadelphia): I just want to express my appreciation of the honor conferred upon me, and to give you my assurance that I will use my utmost endeavors to make the work of the coming year a success. (Applause.)

THE PRESIDENT: I will call on Mr. J. W. Batten.

MR. J. W. BATTEN (Detroit, Mich.): All I can say is that I thank you gentlemen for the honor you have conferred on me, and I will give my assurance to the President that I will do all I can to advance the interests of the Institute. (Applause.)

THE PRESIDENT: Mr. J. A. Norcross is not here. I will now call on Mr. George B. Evans.

MR. GEORGE B. EVANS (St. Louis, Mo.): Mr. President, I first want to express my appreciation and pleasure at being chosen to the office of Vice-President of this Institute, and I hope I will be able to serve in a manner satisfactory to the Institute. (Applause.)

THE PRESIDENT: The next gentleman has been elected a Director, but he has ably co-operated with one of the Vice-Presidents all through the current year. I will call on Mr. H. C. Abell.

MR. H. C. ABELL (New York, N. Y.): Mr. President, and gentlemen, I feel greatly indebted to you for the honor which you have conferred upon me, and I shall do my utmost to assist Mr. Forstall during the coming year. Thank you. (Applause.)

THE PRESIDENT: Mr. A. M. Barnes, of Cambridge, Massachusetts.

MR. A. M. BARNES (Cambridge, Mass.): Mr. President and gentlemen of the Convention, I find myself somewhat in accord with the sentiment of the man who, when being ridden out of town on a rail, was asked by one of the by-standers how he enjoyed it. He replied that barring the honor he would much prefer to walk. And barring the honor of being a Director, I should prefer to remain in the ranks, but you have seen fit to promote me to the office of Director, and I appreciate the honor very highly and shall do the best I can to carry on the good work of the Institute. (Applause.)

THE PRESIDENT: Mr. O. B. Evans.

Mr. O. B. Evans (Philadelphia): Mr. President, I am sorry I cannot express in proper language my appreciation of the honor, but I will have to be satisfied with the mere expression of the fact that I do consider it an honor. I thank you. (Applause.)

The President: Mr. Purcell.

Mr. Theodore V. Purcell (Chicago): Mr. President and gentlemen, I wish to say that I appreciate very much being elected a director, and I shall endeavor to be of service. (Applause.)

The President: The President-Elect ought to feel highly gratified by the abundant assurance of service that has already been tendered.

Mr. Ramsdell.

Mr. Geo. G. Ramsdell: Mr. President, all I can do will be to coincide with the views which have already been expressed. I am very much in hopes that we will have a banner year. Both officers and members have tried to push the work forward so that we could accomplish greater things as we grew older, and I think that it is only fair to say that we have at least succeeded to an extent. Now we are starting a new year, and I should like to add anything that I can towards the development of this organization, and I feel sure that the rest of you feel likewise.

I did not expect to say anything but I would like to take this opportunity to call the attention of the members to what a vast amount of help they would be to us if they would assist in the work of the Gas Institute *News*. That ought not to be a one-man-power work. There are many things that occur in "the day's work" that you may not think important, because so familiar to you, that become very interesting matters to others.

We have the Question Box, which we think ought to be full of questions and answers all the time. The Wrinkle Department, I feel, is rather neglected. I find wrinkles from our members in other periodicals that I think ought to be in the *News*. I hope you will bear this in mind, gentlemen.

And as for myself, I am very glad to have been re-elected, and wish to announce that I will do all that I possibly can during the coming year. (Applause.)

THE PRESIDENT: The Secretary, I know, is very happy to get this opportunity to talk about his baby, the Gas Institute *News*. It is his creation, and I hope that you will so burden him with contributions for the particular departments that he mentioned, that he will be full of happy wrinkles, not only in the Gas Institute *News*, but in his own countenance.

THE SECRETARY: Thank you.

THE PRESIDENT: The Institute would like to hear from the President of the Illuminating Engineering Society, Mr. Serrill.

MR. W. J. SERRILL (Philadelphia): Gentlemen of the Institute, I thank you for this cordial greeting, in the name of the Illuminating Engineering Society, which has done me the great honor of electing me its President for this year.

The management of the Illuminating Engineering Society is very desirous of strengthening the gas interest in the Society. We sometimes hear it claimed that the electric interests predominate. In a certain sense they do, but it is not because the gas men are not welcome. The electric men are, as you know, energetic and aggressive, but the gas men have an equal chance, if they will display similar activity and interest.

The Papers Committee is at the present time hunting for papers from gas sources, and there is a desire to increase the gas membership.

The work of the Illuminating Engineering Society, in pushing the propaganda of good lighting, better lighting and more lighting, is a work that helps the gas industry. Our business is furthered by the work that Society is doing, and I am sure that it is worthy of the support of gas companies. In a membership upwards of 1,400 there are about 250 men who are likewise members of this Institute. That is under 20 per cent., and it should be larger.

I am now engaged in appointing the committees for the year, and my plan is to put on each committee of the Illuminating Engineering Society one or more gas men who are members, of course, but who possibly have not been as active as I think they might be. In this way I hope to secure a livelier interest among gas circles in the Society's work.

I call attention to the elaborate Lecture Course which the Illuminating Engineering Society has just conducted at the University of Pennsylvania. Reprints of the lectures will be available at reasonable prices in the near future. Every gas man should have one.

I am a great believer in gas lighting, and I deplore the attitude which seems to be prevalent in some quarters, that gas lighting might as well go by default. I think gas lighting has a great future. I have been very much impressed with the way an active New Business Department, backed up by good distribution conditions, can extend gas lighting in active competition with electric lighting. If you will bear with me for a few minutes, I will say something about conditions affecting gas lighting.

I have been amazed at the indifference of many gas men on the subject of gas lighting in the face of the active competition of the electric light. I think, in many cases the gas man wonders what he can do more than he is doing. As the manager of the gas company, he sells all the gas light in his town that he can, and he thinks he has done and is doing all that he can. Now, there are several helpful things that he might do, that some managers do do, but that not by any means all of them do. One of these things is to see that every gas light that appears in public, on the street, or that can be seen from the street, is kept in first rate condition. This seems to me a matter of great importance. It is a discouraging sight, in some towns, to see the bad condition of gas lights in stores, in store windows, in other buildings where the lights are visible from the street, or in gas street lighting, due to lack of proper maintenance.

The manager of the gas company can do the cause of gas lighting no better service than to see that every gas light that appears in public is kept in first rate condition. It is in these public and semi-public lights that gas lighting best advertises itself. Like all other advertisements, unless it is well done, it had better be left undone. Better no gas lights exposed to public view, than those with broken mantles, carboned mantles, unfilled mantles, or dirty or broken glassware.

I believe in street lighting by gas. There is no better way to advertise gas lighting. Every gas company should push for it. Looking upon it as the most effective means of advertising gas lighting, they should not expect to make a profit from it. If done at cost, it can successfully compete with electric street lighting, and modern gas fixtures enable one to obtain even more beautiful effects. Success depends upon one stern condition—an effective and thorough maintenance.

Another thing the gas manager can do in the cause of gas lighting is to use his influence in keeping off the local market, cheap mantles and cheap burners. Cheap mantles form a serious handicap to the cause of gas lighting. The gas company can afford to spend money to get rid of them. Why not an agreement with the department and other stores which sell them, whereby the gas company will keep them stocked with standard mantles at very low prices? The elimination of the bad impression the cheap mantles make on gas consumers will more than offset the cost of this proposed practice.

The manager's duty, however, to the cause of gas lighting is more fundamental still. He must see that the conditions of gas distribution are kept uniform. I am sure that many gas managers do not realize the great importance of doing this.

One condition is gas pressures. There is a lack of appreciation of the importance of maintaining a uniform pressure on the incandescent gas light. There are other points in which uniformity is desirable, but dismissing them for a moment and considering pressure alone, if the pressure is kept uniform, not only uniform in the consumer's house, through the twenty-four hours, but uniform throughout the season, a long step is taken toward the maintenance of the incandescent gas lights in satisfactory condition. In low-pressure systems I advocate fairly high pressures, say upwards of 6 inches, as being not only good in themselves, but as tending to maintain a greater uniformity of pressure at the extremities of the main system.

Uniformity in gravity is not less important. This, also, is not sufficiently appreciated. Owing to changing economic conditions, gas companies will shift from water gas to coal gas or *vice versa,* or will introduce coke-oven gas or make other similar changes, without realizing that in so doing they are throwing on all the incandescent gas lamps in use a change in gravity and in air requirement that is greater than they can bear, unless re-adjusted. If the retention of gas lighting is worth anything to the gas industry something must be done to minimize this evil. In attempting to maintain a standard of candlepower, other equally important standards have been overlooked.

Still another point in the uniformity of the quality of gas, is the hydrocarbon or condensible contents. The gas manager is exceedingly keen to keep gas on the town; he is, unfortunately for gas lighting, less keen as to its uniformity in quality. He would not dream of tearing out the station governor for the purpose of installing a large one, without providing a temporary by-pass, and yet he will not hesitate to tear out a scrubber or a condenser without putting in a temporary substitute, and thus for a brief period, to put on the town a gas that will extinguish every pilot light in use. The effect on the reputation of gas lighting is irreparable.

Purification is still another item. Ordinary purification removes the principal sulphur contents; but fails to take out the CS_2. This small remaining sulphur content is largely instrumental in the blackening of ceilings and the discoloration of burners and fixtures—one of the greatest practical objections to gas lighting. If gas lighting is to have a fair chance, the CS_2 should be removed.

My object in speaking of these things is to get you to realize—to create in you, if possible—a new sense of responsibility for a uniformity of the conditions under which our energy is supplied to our burners. We cannot afford to lose our gas lighting business, because it is the form in which manufactured gas is kept in the public eye. Solely as an advertisement it is worth while, but it can also be made to pay, if the gas manager will foster it wisely.

Gentlemen, I thank you.

THE PRESIDENT: The next order of business is the report of the Public Relations Committee. Before calling for that report I will state that I have a letter from Mr. J. B. Klumpp, the Secretary of the Public Relations Committee, in which he says: "It is with great regret that I am compelled to write you that it will be impossible to attend the annual meeting, and present the report of the Public Relations Committee."

In Mr. Klumpp's absence, Mr. Cowdery will kindly present the report of the Committee on Public Relations.

MR. E. G. COWDERY (Chicago): Gentlemen, the report of the Public Relations Committee has been printed and circulated. It is some three or four pages of finely printed matter, and it is hardly necessary for me to take up the time of this meeting to read it, so I would merely call your attention to the printed report of the Public Relations Committee.

REPORT OF PUBLIC RELATIONS COMMITTEE.

September 9, 1916.

BOARD OF DIRECTORS,
American Gas Institute.

GENTLEMEN:

In submitting its report this year, the Public Relations Committee begs to call attention to its monthly reports to the Board of Directors, which have been presented to the membership by publication in the NEWS. These reports covered in considerable detail the work of the committee as it progressed. It will, therefore, be necessary to include in the annual report only a summary of the subjects already presented, and to give the present status of matters now receiving the attention of your committee.

As far as possible, we have kept in touch with the actions of legislative and governing authorities of the various states, as far as they concerned jurisdiction over gas companies, particularly in reference to gas quality and service. We have offered these authorities our assistance and on a number of occasions it has been gratefully accepted.

It is encouraging to note that the rules and regulations enacted by a number of the State Commissions embody many of the suggestions offered by your committee. Rules regulating gas service are to a large extent becoming more reasonable and practicable, which tends to insure satisfactory and efficient service to the consumer by the gas companies.

We wish to express our satisfaction at the co-operation of the various state gas associations, which have been of great assistance to us in carrying on our work. As an example, we may call attention to the excellent work done in Pennsylvania in obtaining a reversal of an order of the Department of Labor and Industry in that State, prohibiting the use of gas for the illumination of basement bakeshops.

The membership of the American Gas Institute can only obtain the greatest benefits from the Public Relations Committee's work by keeping the committee in close touch with conditions in all sections of the country. An effort was made last winter to strengthen our relations, through personal visits to the managers of gas properties in the larger cities of the middle west and on the Pacific Coast. We would request that matters concerning gas legislation and regulation, whether adverse or favorable, be brought to our attention so that information and data can be furnished that will be of value and assistance to the State Commission and to the local operators.

Before leaving the subject of gas service rules and regulations, mention should be made of the fact that all state commissions which have issued rules regulating the quality of gas, have included in them a calorific requirement and have excluded any mention of candle-power.

It is interesting to note that the Board of Gas and Electric Light Commissioners of the State of Massachusetts, after enforcing an illuminating value standard for the past 24 years, has recently issued an order permitting the companies of that State to proceed with an investigation to determine the advisability of dropping its illuminating value standard and adopting the heating value standard.

Similar conditions exist in the First District of New York State, where the Commission has held several hearings for the purpose of determining whether it is advisable to adopt the heating value standard for the City of New York. It is expected that the Commission of the Second District of New York will soon issue an order covering this same subject.

Only one instance has come to our attention where a formal complaint has been made to a state commission requesting a return to the illuminating value standard; in the city of Trenton, N. J., where a State standard of 600 B. t. u. superseded a 22 candle-power city requirement. The complaint was dismissed after a formal hearing. The decision was, that the heating value standard prescribed by the State insured satisfactory service.

Attention is called to a bill passed by the English Parliament on August 3, 1916, permitting all authorities enforcing standards of gas quality of both private and municipal undertakings to drop illuminating value requirements and penalties and substitute a calorific standard. The effect of this order is to put in force generally throughout Great Britain the quality standards that have been imposed on only a few English cities operating under special grants. It seems to have been adopted, after the matter had been before the public, and the calorific standard tried and found satisfactory after many years operation.

The Bureau of Standards has been exceedingly active in its observation and investigation of the gas business for several years. Its staff has produced several circulars pertaining to the gas industry, which have been well prepared and contain much valuable data useful to both gas operators and regulatory authorities. Owing to the number of questions that have arisen in connection with the quality of gas supplied in some sections, the Bureau is now proceeding with an investigation to determine the effect of various gas standards on the service to consumers. Your committee is co-operating with the

Bureau in this work and it is believed that the value of the conclusions will justify the time given.

The national gas safety code now being drafted by the Bureau of Standards has shown considerable progress. The work covering the design and installation of permanent fittings and consumers' appliances has been drafted and criticised by our membership. It is now in the hands of the Bureau for final revision; the rest of the work will be carried on as soon as the time of the staff of the Bureau permits.

It is encouraging to note that so many of our State Associations have either affiliated with the Institute or have expressed a desire to do so. We believe that this co-operation will be the means of continuing national work, particularly along the lines of the work that your committee has undertaken, and that it is only by this co-operation that subjects of national and state importance can be handled most efficiently and beneficially.

Respectfully submitted,

GEORGE B. CORTELYOU, *Chairman,*
SAMUEL T. BODINE,
JOHN A. BRITTON,
E. G. COWDERY,
J. L. RICHARDS,
MORRIS W. STROUD,
J. B. KLUMPP, *Secretary.*

THE PRESIDENT: The report is before you, gentlemen. What disposition will you make of it?

Mr. Brown moves, and Mr. Nettleton seconds the motion, that the report be received and spread upon the minutes, and that the Committee receive the thanks of the Institute for their work during the year.

(The motion prevailed.)

THE PRESIDENT: The report of the Technical Committee. Mr. Barnum, Chairman.

Mr. D. D. Barnum (Worcester, Mass.): The report is printed and published in the *News,* and there is nothing to add to it, so I will not read it to you at this time.

REPORT OF THE TECHNICAL COMMITTEE.

The Technical Committee of 1915-1916 reports as follows:

This Committee has held eight meetings during the past year, and these were held on the same day as the Directors meetings.

All the meetings have been well attended; and in order to enable the members not attending, and also the Directors, to keep track of the work of the Technical Committee, stenographic reports have been made and printed, and given to the members of the Committee, and to the Directors. This has been a great advantage, and we would advise that the practice be continued.

The membership of the Committee is made up of the five Vice-Presidents and nine other members, and the work of preparing the program and obtaining papers for the various sections has been in the hands of the respective Vice-Presidents. This arrangement has worked well, and we wish to call it to the attention of the next Technical Committee.

In the report of the Technical Committee of the previous year, as given on page 54 of volume 10 of the Proceedings, it was suggested that the President, before the close of the annual meeting, select the Technical Committee. Your Committee wishes to endorse this recommendation, and suggests that the Secretary draw this to the attention of the incoming President.

The second recommendation, in regard to continuing and temporary committees, will be dealt with in this report under the subject of sub-committees.

The third recommendation, also, should be drawn to the attention of the incoming President.

Concerning the fourth and fifth recommendations, your Committee has ascertained, as far as possible, the members of the various sub-committees who should be continued as members of such sub-committees during the coming year, and will give their names to the new Chairman of the Technical Committee.

Specifically, your Committee recommends as follows:

First, that the meetings of the Technical Committee be held monthly;

Second, that the five Vice-presidents be appointed members of the Technical Committee, and have charge of their respective programs;

Third, that a stenographic report be made and printed, and distributed to the members of the Technical Committee and the Directors;

Fourth, that the incoming President select the Technical Committee immediately on the adjournment of the annual meeting;

Fifth, that the following sub-committees be continued, and that the members of these sub-committees be appointed as soon after the annual meeting as convenient: Carbonization, Standard Tests, Refractory Materials, Electrolysis, Distribution Standards, Pipe Joints, Gas Fuel Appliances, International Uniform System of Pipe Threads, Gas Lighting, Classification of Gas Engineering, Misleading Statements and By-Products;

Sixth, your Committee wishes to call the attention of the next Technical Committee to the final paragraph of Section 55 of the Constitution, as follows:

> "Upon request of the affiliated association the Technical Committee will co-operate in all matters within its province. Abstracts of papers presented to the affiliated association will, after approval by the Technical Committee, be published in the NEWS, as will complete papers undertaken by agreement with the Technical Committee."

The schedule of the program is as follows:

TUESDAY MORNING, OCT. 17th.

Meeting called to order 10 A. M. Welcome. Report of Directors. Report of Membership Committee. Report of Secretary and Treasurer. Report of Finance Committee. Report of Technical Committee. President's Address. Report of Nominating Committee. Appointment of Committee on Next Place of Meeting.

Report of Committee on Classification of Gas Engineering
H. W. Peck, Chairman

Report of Committee on Misleading Statements
A. E. Forstall, Chairman

Report of Committee on Nomenclature.......R. B. Harper, Chairman

Measuring the Flow of Unpurified Gases at High Temperatures
J. M. Spitzglass

Intermission.

TUESDAY AFTERNOON, OCT. 17th (MAIN SESSION).

Manufacturing Section.

Report of Committee on Carbonization......C. W. Hunter, Chairman
How One Gas Company Handles Its Coke Business....F. W. Seymour
Report of Committee on Refractory Materials..J. W. Batten, Chairman
Report of Committee on Standard Tests........J. F. Wing, Chairman
Oils for Water Gas....................................F. L. Weisser
By-product Coke Plant..............................C. J. Ramsburg

TUESDAY AFTERNOON, OCT. 17th (AUXILIARY SESSION).

Accounting Section.

The Bulletin System as a Means of Instructing Employees..C. S. Ritter
Merit System..W. D. Kelley
Organizing for Cost Reduction in the Consumers' Bookkeeping Department............................F. H. Patterson

WEDNESDAY MORNING, OCT. 18th (MAIN SESSION).

Distribution Section.

Gas versus Electric Cooking...........S. C. Bratton and G. D. Mantle
Report of Committee on Distribution.......J. D. von Maur, Chairman
Report of Committee on Distribution Standards
W. C. Morris, Chairman
Report of Committee on International Uniform System of Pipe Threads ....W. C. Morris, Chairman
Report of Committee on Supplying Large Buildings with Gas....................................O. H. Fogg, Chairman
Industrial Gas Appliances...........................S. Tully Willson
Report of Committee on Consumers' Meters
W. K. Harrington, Chairman

WEDNESDAY MORNING, OCT. 18th (AUXILIARY SESSION).

Accounting Section.

Cost Records on Appliance Installations..............H. B. Lohmeyer

Outline of Credit System in Operation by Peoples Gas Light & Coke Company..............................Robert Blair

WEDNESDAY AFTERNOON, OCT. 18th.

Trip to plant of Sears, Roebuck & Company.

THURSDAY MORNING, OCT. 19th (MAIN SESSION).

Distribution Section.

Manufactured Gas for House Heating G. S. Barrows and C. C. Winterstein

Report of Committee on Utilization of Gas Fuel Appliances..................................W. J. Serrill, Chairman

Report of Committee on Gas Housepiping.....G. I. Vincent, Chairman

Report of Committee on Pipe Joints..........G. I. Vincent, Chairman

Unit Costs in Distribution Work.....................A. A. Treadway

Oxy-acetylene Welding in Distribution Work...........Charles Wilde

Intermission.

THURSDAY AFTERNOON, OCT. 19th (MAIN SESSION).

Chemical Section.

Report of Committee on Chemical Tests.....C. C. Tutwiler, Chairman

Equivalent of the Observed Heat Value of the Light Oil Scrubbed from Coke Oven Gases..................J. W. Shaeffer

The Removal of Sulphur from Spent Oxide.............E. J. Murphy

Purification of Water for Gas-making Purposes.....W. H. Fulweiler

Some Characteristics of Gas Oils......................E. C. Downing

THURSDAY AFTERNOON, OCT. 19th (AUXILIARY SESSION).

Illumination Section.

Gas Ignition...T. J. Litle, Jr.

Chicago's Experience with a Separate Lighting Division..C. A. Luther

FRIDAY MORNING, OCT. 20th (MAIN SESSION).

Illumination Section.

Report of Committee on Gas Lighting..........C. O. Bond, Chairman

Street Lighting.

General Meeting.

SUB-COMMITTEES.

Committee on Carbonization.

This Committee has endeavored to obtain figures showing operating results from as many of the horizontal, inclined and vertical settings and by-product oven plants built in recent years as possible. The data submitted was collected with a great deal of difficulty, and the Sub-committee is not satisfied that the figures are, in all cases, comparable, owing to the fact that the plants were not operated under similar conditions.

This Committee has also endeavored to obtain, and has done so in a general way, means adopted by the principal companies for marketing and delivering coke. This is a valuable paper, and represents a great deal of work.

This Committee should be continued.

Committee on Gas Works Auxiliaries.

This Committee was unable to formulate a report, but the Chairman, in order to help out the program, kindly prepared a very good paper on the subject of "Measuring Flow of Gases From Individual Generator Sets."

Committee on Standard Tests.

This Committee has endeavored to formulate rules and specifications for testing coal and water gas plants.

It first emphasizes the demand for comparable or uniform methods of stating the results of testing, or, more broadly, the results of operating a manufacturing unit or plant. The object of this standardization is to facilitate the study of the efficiency of materials, apparatus and methods by comparing the results obtained at different times and places.

There are many items in the code, but it is thought that any of the data called for might be considered of influence.

Your Committee feels that this is very important work, and should be carried on another year, after this report has been freely discussed at the annual meeting.

Committee on Refractory Materials.

This is the third year of the existence of this Committee, and sees the development, and to some extent the accomplishment of the aims and purposes of the Committee, as set forth by its former chairman, Mr. Herman Russell.

Very satisfactory progress has been made in the determination of the conditions which refractory materials must meet in practice, particularly with respect to those refractories met with in coal-gas installations, and close approximations have been made regarding the qualities which such material must possess, in order to best meet those conditions. Determination of reliable and practical methods of making the various tests, such as porosity, refractoriness, resistance to slagging action, and the like, is still in the hands of Committee C-8, of the American Society for Testing Materials. As soon as these methods have been decided upon, the practical value of the work of the Refractory Materials Committee should be readily demonstrable.

This Committee should be continued.

Committee on Chemical Tests.

Since the last meeting of the Institute, the Committee on Chemical Tests has directed its activities chiefly towards the revision of the Gas Chemists' Handbook compiled in 1914, by Mr. W. H. Fulwiler.

While the Committee feels that distinct progress has been made in the handbook, it is not prepared to recommend that all of the methods contained therein be stamped with the official approval of the Institute, without further revision by succeeding chemical tests committees, or by a special committee appointed for the purpose, except possibly the methods covering the analyses of coal, coke, cement, iron and steel. All of these may safely be adopted, it is thought, since the method for analyses of coal and coke is based on the work of the Bureau of Mines, and those for cement, iron and steel from the official methods of the American Society for Testing Materials.

The desirability of having the whole work officially approved by the Institute seems apparent, and since its value would be so much increased by such action of the Institute, the Committee feels that no unnecessary time should be lost in taking the necessary steps to further standardize and enlarge the work.

Committee on Distribution.

Mr. von Maur, the Chairman of this Committee, has helped the Technical Committee during the year to look after the work of the various sub-committees under distribution, and this work has been collected under a general committee called the Committee on Distribution.

Committee on Consumers' Meters.

This Committee has tabulated a large amount of information of facts and data collected by sending questions to various companies.

The question of deterioration of consumers' meters has received unusual attention during the past year, in England, and your Committee draws attention to the work done, as described in three articles: "Destructive Influences on Gas Meters," "Life of Gas Meters," and "Life of Gas Meters Research," in *The Journal of Gas Lighting and Water Supply,* pages 557, 563 and 586. They recommend that a committee be formed by the Institute to carry on the work in this country, along similar lines and for the same purpose.

Committee on Electrolysis.

The Committee on Electrolysis makes the following progress report for the year 1915-16.

This Committee attended a meeting of the American Committee on Electrolysis, formerly called the Joint National Committee on Electrolysis, in New York on June 30, 1916, where the day was spent in discussing the second galley proof of the Preliminary Report.

The meeting then adjourned to allow each member further time to examine the report and to submit to the Publication Committee any desired changes in this report. These suggestions were incorporated as far as possible in the third galley proof. Copies of the corrected proof were sent to each member and on September 21st and 22nd the Committee again met in New York and devoted five sessions to the careful consideration of the report in detail.

The report as amended at these meetings was finally unanimously adopted by the Committee. There were present twenty members, including the three representatives of the American Gas Institute and two representatives of absent members.

The National Associations represented on the American Committee on Electrolysis are:

American Institute of Electrical Engineers,
American Electric Railway Association,
American Railway Engineering Association,
American Telephone and Telegraph Company,
American Water Works Association,
National Electric Light Association,
Natural Gas Association,
American Gas Institute,

and one representative of the Bureau of Standards.

It was hoped when we adjourned that the final proof, paged and with inserts, would be ready so that each member of the Committee could receive two copies and ten copies for each association.

This report is a preliminary report, which confines itself to statements of facts without any recommendations. On its title page appears the words "Printed but not Published."

It is understood that the report will not be published until the several associations have approved the report.

A new sub-committee, with one representative from each association, has been selected to continue the work and draft recommendations for a report on the Prevention or Mitigation of Electrolysis.

Prof. Albert F. Ganz has been selected as the representative of the American Gas Institute on this new committee.

Our Committee regret that it is unable to submit the Preliminary Report for approval at this time, but we urge that the report be given early attention after its receipt, as the gentlemen's agreement between the associations represented will prevent its publication until approved by all the associations.

We believe there is valuable information in this report which should be published as soon as possible.

Committee on Cast Iron Pipe Joints.

A preliminary report of the Committee was submitted at the meeting of the Institute held in San Francisco in 1915, and there read by title. In order to promote discussion, the report was published in the December number of the Institute NEWS and discussion requested. Several interesting discussions were submitted and published in subsequent issues of the NEWS.

Due to the printing of the report, and discussions and suggestions made thereon, this year's Committee recommends certain changes in specifications of last year's report.

Subsequent to the presentation of the preliminary report, the Committee was continued and has been at work during the year in collecting additional data, particularly from large situations, and endeavoring to arrive at some definite conclusion as to the ultimate form which the report will take. At least two series of experiments are under way, but the data is not available as yet. They propose for committee work the coming year as follows:

1st. The investigation with the idea of producing a satisfactory cement joint for large mains should be continued.

2nd. As cast lead joints and lead wool joints and combination joints will continue to be used, specifications should be prepared for each of these types of joints.

3rd. The Committee should investigate the special forms of cast-iron pipe joints, such as flange joint, turned and bored, plain end, etc.

4th. A clamp to go over standard bell and spigot pipe should be designed.

5th. If possible, the final report of the Committee should embody recommendations of the types of joints to be used under the several pressure conditions, *i. e.*, low, medium and high.

These five suggestions are made for discussion at this coming meeting. They represent what your Committee believes should be undertaken by the Committee, if it is proposed to continue this work. The Sub-committee recommends as follows:

1st. That the outline of the proposed report be freely discussed at this meeting.

2nd. That a committee be appointed to continue the work, and present a final report at as early a date as possible, embodying the suggestions as outlined, with such modifications as may be brought out by discussion at this meeting, or which may be recommended by the Technical Committee.

Committee on Distribution Standards.

On the specific subject of Pipe Standards, your Sub-committee reports a gradual progress toward the universal adoption of the standard specifications.

Your Sub-committee was this year, without alteration in personnel, changed in title and had its powers enlarged by becoming a Committee on Distribution Standards. The Technical Committee believed it advisable there should be one committee to which all questions as to Distribution Standards should be referred, and which committee would consider the advisability of proposing to the Institute additional distribution standards.

Your Sub-committee believes that the effect of so general a commission as the one given it is not as conducive to definite accomplishments as a plan of providing a separate, and probably smaller, committee for each specific job. As stated above, your Sub-committee thinks there should be a continuation of the supervision over pipe standards, but it does not advocate the continuance of the Committee on Distribution Standards as now constituted.

This Committee should be continued as above recommended.

Committee on Gas Housepiping.

The work of this Committee was carried on, and largely formulated by Mr. C. E. Reinicker, and the report was submitted at the San Francisco meeting for discussion. It was then revised according to the discussion, and after Mr. Reinicker had resigned from the chairmanship of this Committee, Mr. Vincent was appointed to take up the work of the report, and some minor changes were made and the final agreement of the Committee obtained,

It is recommended that this report, after discussion in the open meeting, be referred to the Committee on National Gas Safety Code, with power to substitute, enlarge or amend—the final approval of the report, however, to be left to the Directors of the American Gas Institute.

Committee on Supplying Large Buildings With Gas.

This Committee, after considerable consideration of their subject, decided that the writing and publishing of a handbook was not the proper manner of handling the subject; and that the report as written by the Chairman, Mr. Fogg, showing the methods which should be used to advance the installation of piping in large buildings, would best be served by solicitation among the builders and architects.

Their final conclusion was that the Institute would not be justified in going to the expense of publishing a pamphlet on the subject.

Committee on Utilization of Gas Fuel Appliances.

This Committee has continued its work, and recommends that an agreement be reached between the National Commercial Gas Association and the American Gas Institute, whereby the standard specifications for gas ranges and gas fixtures which have already been jointly adopted by these two societies be printed under titles which so state this fact.

This Committee recommends a tentative specification in regard to a flexible tubing, which shall be substantially as safe as a rigid metal pipe.

Their position in regard to slip joints is no different from that taken several years ago, and they believe a substitute joint should be found.

They also recommend, until such time as a substitute slip joint is found, that the slip joint be standardized, and they submit a joint designed by the Appliance Committee of the National Commercial Gas Association.

This Committee should be continued.

Committee on International Uniform System of Pipe Threads.

As there has been no conference of the Committee on International Uniform System of Pipe Threads, the Committee of the American Society of Mechanical Engineers and the American Gas Institute have not, during the year, held any joint meeting, and therefore there is no progress to report.

Committee on Classification of Gas Engineering.

Our representative, Mr. Peck, has been appointed Chairman of the Joint Committee on this subject.

They have taken up the scope of the work, and ways and means of carrying it along. They have held many meetings in New York, and have divided the work among sub-committees.

A substantial start has been made in the organization for carrying on the work, and your Committee recommends that this report be carefully read by the Directors.

This Committee should be continued.

Committee on Misleading Statements.

Mr. A. E. Forstall, Chairman of this Committee, as you all know is exceptionally well fitted for the work. He has answered many statements made by papers and magazines.

This Committee should be continued.

Committee on Nomenclature.

Mr. Harper has organized this Committee, and started the wheels toward accomplishing the compilation of a nomenclature.

The work is well under way, and this Committee undoubtedly should be continued.

Committee on By-products.

The Chairman of the Technical Committee has endeavored in every way to obtain a member for Chairman of this Sub-committee, but so far his efforts have been entirely unsuccessful.

The by-product engineers seem to be overloaded with work this year, but we recommend that the Committee be continued, in the hope that the next Chairman will be more successful in obtaining someone to handle this work.

Committee on Gas Lighting.

The Committee on Gas Lighting reports:

1. Results by per cent. differences of intercomparison between four laboratories, of tests made on several incandescent gas lamps.
2. Classifies answers received from sixty members making suggestions for increasing or bettering gas lighting.
3. Reviews the various factors that enter into good gas lighting service and discusses each.
    - (*a*) Gas quality and service;
    - (*b*) Piping, fixtures and accessories;
    - (*c*) Lighting units;
    - (*d*) Human element—especially as it affects maintenance.

The Technical Committee have approved all papers and subcommittee reports presented at this meeting.

Dana D. Barnum, *Chairman,*

H. C. Abell,
C. O. Bond,
C. M. Cohn,
J. P. Crowley,
A. H. Elliott,
O. B. Evans,
O. H. Fogg,
A. E. Forstall,
R. B. Harper,
Herman Russell,
J. W. Shaeffer,
C. C. Tutwiler,
E. C. Uhlig,
J. D. von Maur,
J. F. Wing.

THE PRESIDENT: The gentleman who has just spoken is undoubtedly the hardest working member of the Institute in its behalf during the year. He does not seem to waste many words, but I know that he wrote in connection with the business of his office during the year, eleven hundred letters to carry out the preparation of the program. He certainly is particularly brief in stating the result of all his work.

Mr. Taussig moves, and Mr. Purcell seconds the motion that the report of the Technical Committee be received and spread upon the minutes, and that the Institute tender its earnest thanks to the Chairman and his associates for their work during the year.

(The motion prevailed.)

THE PRESIDENT: The Committee on Arrangements. Mr. Cowdery, Chairman.

MR. E. G. COWDERY (Chicago): The entertainment features provided by the Committee on Arrangements have been printed in the little program that has been circulated. The Committee have endeavored to make such arrangements as will cause the business of this meeting to progress in a systematic manner and smoothly. It has arranged a Bureau of Information located in the Elizabethan Room on the first floor. It will be there continuously during the days of this meeting throughout the week. It is intended that anybody who wants to know anything about what is going on at this meeting shall get their information from this Bureau.

This meeting adjourns at 1 o'clock to-day, and assembles again at 2.30. Likewise on Thursday of this week in the same manner. We have provided a number of tables which are reserved for the members in the north end of the Palm Room, which will be ready for you at 1 o'clock, so that you may be able to get your lunch promptly. I said that these tables were reserved to-day and Thursday. Wednesday, as we adjourn without returning to the meeting, we have made no arrangements regarding the noon luncheon here, and on Friday likewise we have made no arrangements to reserve tables, because there is no pressure for time at that time.

THE PRESIDENT: I trust we will all avail ourselves of the ample arrangements provided by the committee.

MR. D. D. BARNUM: Mr. President, I move you that a vote of thanks be tendered to this Committee on Arrangements, who have done so well in taking care of our wants and arranging so many conveniences and comforts for us during our meeting.

(The motion was duly seconded and carried, and a vote of thanks tendered the Arrangements Committee by the members.)

THE PRESIDENT: The next order of business is the report of the Committee on Resolutions.

MR. R. B. BROWN (Milwaukee): Mr. Chairman and gentlemen, in the absence of Mr. Addicks, I wish to present for his Committee the following resolutions which have been approved by the Board of Directors for presentation to the Institute, and we ask their adoption:

"*Resolved,* That the total heating value in manufactured gas best represents its quality for standard requirements; and

"*Further resolved,* That the American Gas Institute recommends the adoption of the total heating value as the only standard basis of rating the quality of all manufactured gas distributed in the United States."

Experience has demonstrated that in establishing any definite calorific standard for gas, the following are conditions that govern:

1. In any calendar month gas should on the average at least meet the standard fixed.
2. Except in case of accident or other incident of manufacture reasonably beyond control, the average of any day's determinations should not fall below the standard fixed by more than 10 per cent.
3. Where gas is compressed the heating value shall be determined before compression.
4. Gas should not be required to contain such percentages of constituents as to render the gas unstable under varying conditions of atmospheric temperatures and pressures.

5. The standard adopted should not necessarily restrict the use of materials or processes to the detriment of economical manufacture or to prevent the conservation of natural resources.

6. Materials and processes may be used whose by-products of manufacture are of military value to the Government.

THE PRESIDENT: Gentlemen, you have heard the report. The motion is upon the adoption of the report and the recommendation.

MR. A. E. FORSTALL: Mr. President, I move that the resolution be adopted.

MR. MORRISON: Seconded.

THE PRESIDENT: It is moved by Mr. Forstall and seconded by Mr. Morrison that the resolutions as read by Mr. Brown be adopted.

(The motion prevailed.)

THE PRESIDENT: The next item of business is the report of the Committee on the Revision of Constitution and By-Laws.

MR. R. B. BROWN: Mr. President and gentlemen: On behalf of the Committee on Revision of Constitution and By-Laws I have to submit two amendments to the Constitution, both of which have been passed upon by the Board of Directors and approved for submission to the Institute.

First: "SECTION 6-B: A 'gas company,' as used in Section 5 and Section 6, shall be construed as including operating by-product coke oven companies or any other companies which are engaged in the manufacture, sale or distribution of gas, whether the distribution of its product is wholesale or retail."

You will note that that opens the road to our active membership to all qualified engineers or responsible executive officials from any companies which are engaged in the manufacture of gas for distribution purposes. The Committee feels that this broadening of the field is very desirable at this time, that we shall be in position to avail ourselves of all the knowledge and all the assistance which may come from this very rapidly increasing development of our industry.

The second amendment to be submitted is as follows:

"SECTION 27: The Board of Directors may appoint annually and fix the salary of an Assistant Secretary. The Assistant Secretary shall represent and act in the place of the Secretary during the Secretary's absence or disability, and under the supervision of the Secretary shall perform such other functions or duties as the Board may authorize."

It was found necessary during the course of the work of the Institute this year for the Board to make an emergency appointment of an Assistant Secretary, and this constitutional amendment simply makes regular that action. The work of the Institute and its various committees being centralized in New York, has added a great deal to the duties of the Secretary, and it is very desirable, and it was very necessary that he have additional assistance in a way that our various standing committees could call upon this Assistant Secretary for special work, which was entirely beyond the ability and the time of the Secretary to give attention to. We ask the approval of these two changes in the Constitution.

I will also at this time read a change in the By-Laws which does not require the approval of the Institute, but for your information only. It has been adopted by the Board of Directors.

"By-Law 25 (Section 44) of the By-Laws be amended to read as follows: 'The President shall appoint a committee of three to recommend the place for the next annual meeting, which committee shall report to the Board of Directors at the meeting of the Board next following the adjournment of the next Annual Meeting.' "

It has been the practice in the past for this Committee to report to the Institute at some session of the Annual Meeting. It is thought desirable for the incoming administration, after they have arranged their organization, to have the opportunity to discuss this question of the place of meeting with the committee before the recommendation is made, and the only way that that can be done is to have the report of the Committee on Next Place of Meeting, come to the Board of Directors, and there seems to be, in the opinion of your Committee, no reason why this should not be done. The Board has accordingly taken that action.

THE PRESIDENT: The question now comes upon the adoption of the amendments to the Constitution which have been read in detail by the Acting Chairman of this Committee, and have been approved by the Board of Directors, and have been recommended by the Board for adoption by the Institute. I will ask action on these separately. The first one is:

"SECTION 6-B: A 'gas company,' as used in Section 5 and Section 6, shall be construed as including operating by-product coke oven companies or any other companies which are engaged in the manufacture, sale or distribution of gas, whether the distribution of its product is wholesale or retail."

In order to facilitate action on this proposed amendment I will state that it is necessary to cast a ballot.

MR. A. E. FORSTALL: I move that the Secretary be instructed to cast the ballot of the Institute for the adoption of the amendment as read.

(Motion duly seconded.)

THE PRESIDENT: Is there any objection? If not, those in favor of the motion that the ballot be cast by the Secretary will please say "aye."

(The motion was carried.)

THE SECRETARY: Mr. President, I hereby cast the ballot of the members of the Institute for the following amendment to the Constitution:

"SECTION 6-B: A 'gas company,' as used in Section 5 and Section 6, shall be construed as including operating by-product coke oven companies or any other companies which are engaged in the manufacture, sale or distribution of gas, whether the distribution of its product is wholesale or retail."

The President: The amendment has been adopted. The question is now on the adoption of the second proposed amendment:

"Section 27: The Board of Directors may appoint annually and fix the salary of an Assistant Secretary. The Assistant Secretary shall represent and act in the place of the Secretary during the Secretary's absence or disability, and under the supervision of the Secretary shall perform such other functions or duties as the Board may authorize."

Mr. A. E. Forstall: Mr. President, I move that the Secretary be instructed to cast the ballot of the Institute for the proposed amendment.

(Motion duly seconded.)

The President: Is there any objection? The motion is made and duly seconded, and there is no objection entered. The Secretary cast the ballot for the adoption of the amendment.

(The motion was adopted.)

The President: I wish to state in relation to the change in the By-Laws which was reported by Mr. Brown, whereby the Committee on Next Place of Meeting is to report to the Board of Directors at their first meeting after the adjournment of the Annual Meeting. This Committee has been appointed. Mr. George Beadenkopf is Chairman. The other two members of the Committee are Mr. Eustace and Mr. Congdon, and I ask those members who are interested in this subject to communicate with these members of the Committee so that they may make their statements before the report is filed with the Board.

The next business is the report of the National Gas Safety Code.

The Secretary: Mr. President, the Committee is not ready to report. They ask the privilege of postponing the report until the meeting Friday.

The President: If it is the pleasure of the meeting this will be a matter of specified business for the General Session on Friday morning.

The next business is the report of the Committee on Analysis of Accidents. Mr. Douglas, Chairman.

MR. JAMES B. DOUGLAS (Philadelphia): According to Bulletin Whole Number 201, August, 1916, of the U. S. Bureau of Labor Statistics, "no department of statistical inquiry more closely touches the public weal than the study of personal injuries by accident. Statistics of industrial accidents should serve for accident prevention, for the due administration and intelligent revision of workmen's compensation laws, and for the computation of compensation insurance rates. For accident prevention it is needful to know how and why accidents occur. For the better administration of workmen's compensation laws it is necessary to have an accurate statistical record. * * * For the intelligent enactment and revision of compensation legislation, legislators must know the number and character of accidental injuries," etc.

The Committee on Analysis of Accidents appointed early this year to continue the analysis work started by the Committee on Accident Prevention several years ago has with your help been able to add some 3,700 individual cases to the experience, bringing it in all up to 10,000 cases. The report is printed, as you doubtless know, and I will draw attention to the charts, and say that I hope you will all make a study of the causes of accidents, assuming that you are all interested, as we are, in accident prevention, in order to know just what points to attack.

The work done during the last few years has now become of real statistical value and has on several occasions during the year been used to show that the gas industry was not particularly hazardous. In one state which I know of, an effort was made to draft a state Safety Code which would associate the gas industry with explosives. A mere glance at this analysis of 10,000 cases is all that is necessary to show that a great injustice would thereby be done the gas industry.

It is interesting to note, also, following along those lines, that in all less than 5 per cent. of the total of 10,000 cases analyzed shows accidents peculiar to the gas industry, that is, to leaks inside and outside, and to explosions. Of course, there are some cases of burns not sustained in explosions which might be included in that, but were not, the thought being that the three classes of cases mentioned cover all the classifications peculiar to the industry.

It has not been an easy matter, to get together these 3,700 additional cases and bring the total up to an experience worth while, but I want to say that we of the Committee are very appreciative of what help has been given to us, and as suggested in the report, recommend, if it is seen fit to continue the Committee or appoint a new one, that the President urge that the interest in this work be made more general, and that the various companies throughout the country take an active interest in reporting their cases.

And, in leaving this report with you, the Committee feels that it has made a start in the right direction.

BOOST
SAFETY
GAS
CO.
CARE
CAUTION
PREVENT
ACCIDENTS

REPORT OF COMMITTEE ON ANALYSIS OF ACCIDENTS.

The Committee, appointed for the first time this year, to continue the analyses of accidents to employees while on duty, has succeeded in bringing the number of cases analyzed up to 10,000, which experience, though still comparatively small, should be of considerable assistance to the managers of gas companies in indicating the points to be attacked in accident prevention work.

Discouraging as have been the results of endeavoring to induce the various gas companies to report their accident cases, the Committee has received a total of 3,763 cases during the

Institute year. The answers made on the accident reports received by the Committee, in its opinion, do not warrant the making up of charts to show other than the causes of accidents and the effects thereof, although as a matter of interest notes on other findings made from the accident reports are included herein.

The following figures are arrived at by combining the analyses for the two Institute years ended September 1, 1916.

Of the 6,499 cases reported during the two years, 5,283 reported on disability, and of that number 2,286, or 43 per cent., reported disabilities amounting in all to 25,036 days, being an average of 10.9 days' disability per case, and in 2,997 cases, or 57 per cent., it was reported that no disability resulted. Of the 2,286 cases of disability, it was found that 478 showed periods of disability of over two weeks each and involved a total disability of 13,346 days, being an average of 27.9 days' disability per case.

It is also interesting to note that of 4,325 cases reported during the two years on length of service, 1,946, or 45 per cent., of the employees injured had been in the company's employ one year or less.

During the two years' period, 6,362 reports indicated the age of the injured employees, which showed the average age to be 33 years.

The analyses made up to September 1, 1915, showed 6,237 cases reported by 119 gas companies in 35 states. Similar analyses for the Institute year ended September 1, 1916, showed 3,763 cases additional, reported by 104 companies in 30 states.

The 27 fatal cases referred to on the Causes of Accidents chart were in more detail due to the following causes:

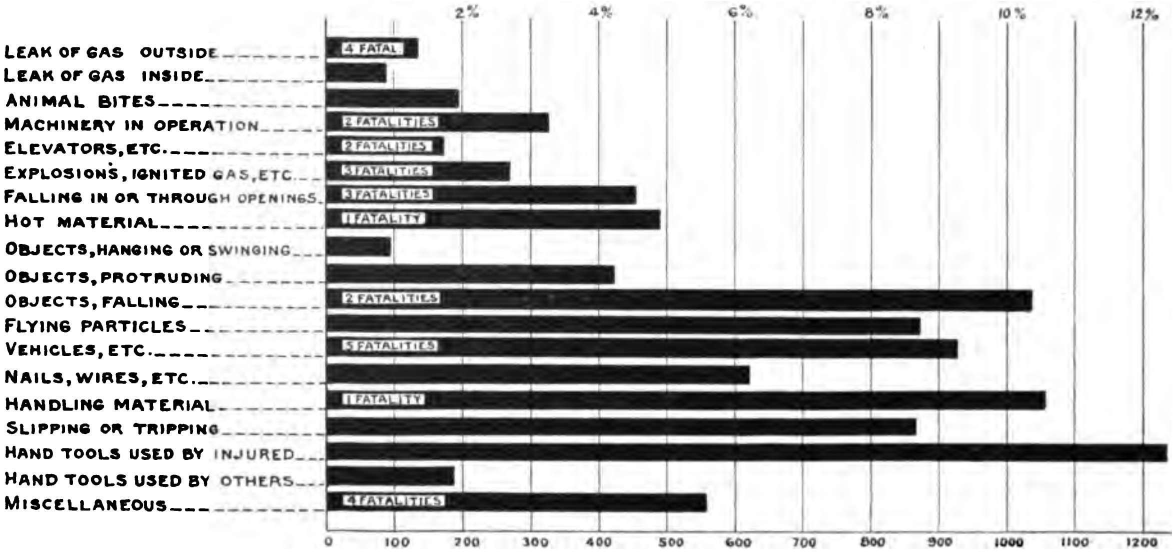
Leak of gas outside:	
Overcome by gas while tapping main	3
Overcome by gas while bagging main	1
Machinery in operation:	
Caught in pulley of coke conveyor	2
Elevators, etc.:	
Fell down elevator shaft	1
Caught between elevator chain and pulley shaft	1
Explosions, ignited gas:	
Burned by gas escaping from generator door	2
Burned by explosion of gas escaping from revivification machine	1
Falling in or through openings:	
Fell from engine	1
Fell into coal hopper	1
Fell from top of mixing tank	1
Fell from coal trestle	1
Hot material:	
Burned by hot tar	1
Objects, falling:	
Struck on head by falling piece of coal	2
Vehicles, etc.:	
Thrown by skidding motorcycle	1
Struck by automobile while at work in ditch	1
Struck by street car	2
Struck by truck while riding bicycle	1
Miscellaneous:	
Burned while extinguishing fire at tar still	1
While scuffling with fellow-employee was thrown to ground, striking stomach	1
Overcome by ammonia fumes escaping from still	1
Heat prostration	1
	27

The work on analyses of accidents from year to year done by the several Institute Committees has become of real value, and on a number of occasions during the year has been used to prove that the gas industry cannot be properly classified as extra hazardous.

CAUSES OF ACCIDENTS

10000 EMPLOYE CASES

GAS COMPANIES

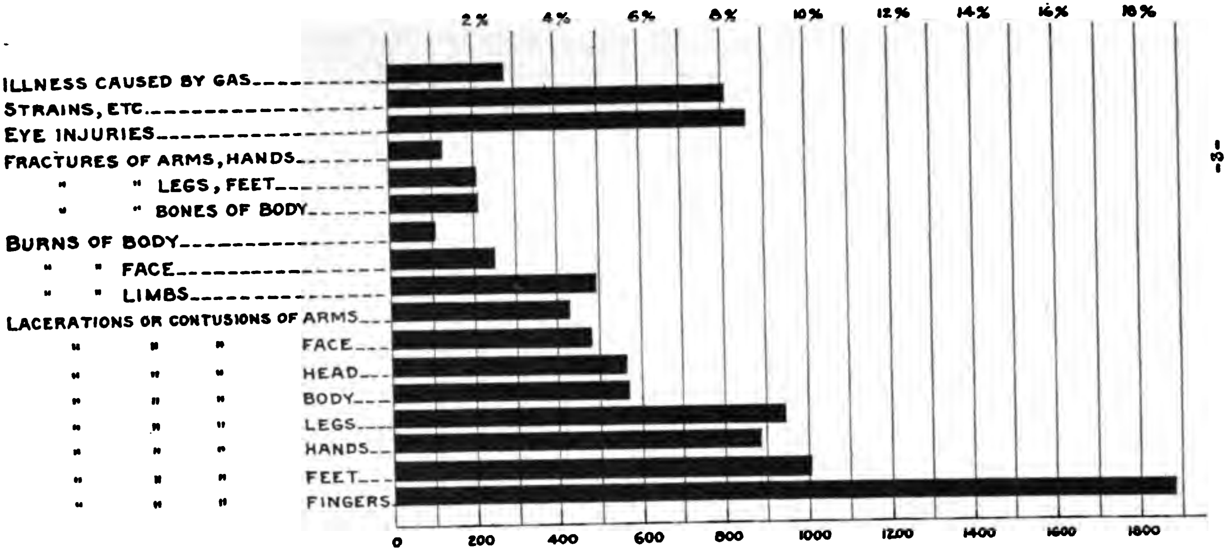


27 FATALITIES

AMERICAN GAS INSTITUTE
SEPT 1 1916.

EFFECTS OF ACCIDENTS

10000 EMPLOYE CASES
GAS COMPANIES



27 FATALITIES

AMERICAN GAS INSTITUTE
SEPT. 1. 1916.

It will be noted that accidents peculiar to the industry, *i. e.*, leak of gas (outside and inside) and explosions, constituted but 4.9 per cent. of the 10,000 cases reviewed. This being positive evidence, should prove convincing to any state body or insurance committee having to do with casualty ratings for the industry.

It is recommended that the work of the Committee be continued, and that the President of the Institute urge the members to make better response to the Committee's requests for reports of accidents.

JAMES B. DOUGLAS, *Chairman,*
CHARLES B. SCOTT,
GEO. OLIVER SMITH.

September, 1916.

MR. G. T. MACBETH (Mt. Vernon, N. Y.): Mr. President, I move that the Committee be thanked for their able work in connection with Analysis of Accidents, and that the report be accepted and spread upon the minutes.

MR. J. E. NUTE: Seconded, Carried.

REPORT OF PRESIDENT OF UNITED STATES NATIONAL COMMITTEE OF THE INTERNATIONAL COMMISSION ON ILLUMINATION FOR THE YEAR

1915-1916.

In accordance with the statutes of this Committee, I beg to submit the following report for the year closing November 1, 1916:

Pursuant to the statutes of the International Commission on Illumination and in accordance with the vote taken at the organization meeting held in Berlin, in 1913, the second meeting of the Commission was to have been held in Paris during the past summer. Owing, however, to the continuance of the war in Europe there has been no activity whatever of the International Commission on Illumination and no communication between the National Committee of the United States and those of the other countries adhering to the Commission.

Notwithstanding the cessation of international activity and the temporary disruption of the international organization it has seemed advisable to maintain the organization of the National Committee in this country. Under these circumstances, however, as stated in last year's report, there is little that can be done by the United States National Committee except to stimulate interest in the study of those questions which are of importance to the International Commission, and in particular to encourage the investigation of problems pertinent to the science and art of illumination. The responsibility for cherishing the ideals of the Commission rests in part with the United States and when international order is once more established this country should be prepared to furnish technical material for international consideration. Therefore, although no funds are required at present from the technical societies of the United States for the support of the International Commission it is hoped that the technical societies will lend their interest and support in advancing the science and art of illumination in this country.

Respectfully submitted,

EDW. P. HYDE, *President.*

Mr. Batten moved, Mr. Mueller seconded the motion to accept the report and publish in the PROCEEDINGS. Carried.

THE PRESIDENT: Has any member any general business before we resolve ourselves into the Manufacturing Section? If there is no other general business I will call Mr. Abell to the chair and the General Session will now be adjourned until Friday forenoon, and the Manufacturing Section program will now be continued.

Thereupon the General Session was adjourned to Friday, October 20, 1916, at 10.30 A. M.

MANUFACTURING SECTION.

First Session, Tuesday, October 17, 1916, 12 o'clock Noon.

MR. H. C. ABELL, *Vice-President*, presiding.

MR. J. S. JACKSON, *Secretary*.

THE CHAIRMAN: The Manufacturing Section will kindly come to order. The first on the program for the Manufacturing Section is a paper by Mr. J. M. Spitzglass on "Measuring Flow of Unpurified Gases at High Temperatures."

MR. J. M. SPITZGLASS (Chicago): Gentlemen and Mr. Chairman, knowing how valuable the time is, I will make it as brief as possible, just giving you the meat of the paper and then you can consider the balance later.

Fig. 1 opposite page 82 of the paper, shows the top of the superheater, and the inlet and outlet of the wash-box of a gas machine. Gas flowing from the superheater into the wash-box is at a temperature of about 1,200°, flowing from the wash-box is at a temperature of about 180°. When we started this work we did not know which place would be better for our work to measure, and we made experiments first on the inlet to the wash-box at the higher temperature. We found that we could measure the flow; that is, it would be indicated on the gauges, but it was very hard to keep the tubes clean for doing the work. There is one Pitot tube shown at the inlet and one at the outlet, and the two are connected to gauges, one of which is near the wash-box, and the other at the gas maker's desk which is the present location of the gauge at Pitney Court Station.

While trying to measure the gas at the inlet to the wash-box we endeavored to find a tube that would do the work and which would not be clogged up by the carbon in the gas.

By the drawing after page 84 you will see how we followed that work. We first put in what we called a multi-opening tube; the kind that was explained in last year's report of the Committee on Gas Works Auxiliaries. This tube stretches along the whole diameter of the pipe. The tube has two sets of openings in opposite directions, and when the flow starts it sets up a differential pressure in proportion to the impact of the flow. This tube was plugged up after the first 24 hours and we thought the reason was because the openings were too small. We changed it to tube No. 2, with larger openings, but that did not help much. Then, since we wanted to keep on with the work, we decided to experiment with single openings in the tubes, thinking they would not plug up so easily.

Then we tried tubes 3, 4, 5, 6, 7 and 8, and found that tube No. 8 was the best, and the only change we made after this is what we call tube No. 9, which had the angle increased to 70° from the horizontal. In the tube shown on the drawing the angle is 60°.

This tube, operated at present at Pitney Court Station, has been in operation for 6 months, and did not clog up. We clean it once a week with steam, and have it connected to gauges indicating the flow of gas from each generator. I will not claim that it solves all the problems of gas manufacture. It does give us some information. But the main thing is that it is so easily installed that you can well afford to try it.

On page 87 you will find from there to page 95 a number of charts that represent tests we made from indications of this Pitot tube. These show what inferences we can draw from the readings of the gauges to improve the operation of the machine. The charts show very plainly that when the right amount of steam is used, the line representing the gas made during the run will be practically straight, it will follow the theoretical line more closely, and when we do not have the right amount of steam it will make a little more during the beginning of the run and will drop off. It will not be as efficient as the other case.

On page 97 in an arrangement shown of a similar installation at the Fulton Works of the Brooklyn Union Gas Company, where they have done similar, work. They had the Pitot tube in a vertical pipe quite a distance from the wash-box, which in a way is better than ours, which is closer to the wash-box, and in other respects was not as good, for they were bothered with the excessive condensation coming from the wash-box on account of the line being vertical.

On page 98 are given readings of the gauge as compared with a station meter. You will find that the average readings correspond very closely with the station meter, while the individual readings are as far apart as 7 or 8 per cent., or more, but this is due to the fact that the time of the run during the hour is taken from nominal run. You take for instance a run of 4 minutes, and you consider it as 4 minutes, though it may be a little shorter or longer, while the true indications of the gauge are momentary. If you take the average time, you cannot be accurate on each reading. But these readings are accurate enough for all practical purposes.

Those of you who are interested in the subject will find it convenient probably to visit the Pitney Court Station of the Peoples Gas Light and Coke Company, where you will see this device in operation, and have it explained thoroughly by Mr. Connors and Mr. Wooden, who did most of the work on it.

I will take only a few minutes to explain to you the tables given with this paper. They appear on pages 105 to 115.

I thought while I was making out these tables that I would include some additional information which may prove to be very useful. Table I gives the general properties of dry air from 0° to 212° F., and also the pressure and density of saturated water vapor, the headings being self-explanatory. The volume factor given in the table is actually the correction factor for dry gas, but I call it volume factor in order to differentiate it from the correction factor for saturated gases.

Table II gives certain properties of saturated gases which apply to all gases in general, independent of their specific gravity. The first column is the partial gas pressure in pounds per square inch. That is the pressure occupied by the gas alone, leaving the balance of 14.7 to be exerted by the water vapor in the saturated gas.

The second column is the proportion of dry gas in the mixture, that is, the portion of pressure exerted by the dry gas alone, for instance, at 0°, this portion is 0.998 and a twothousandth part of the pressure is exerted by the water vapor even at 0° F.

Of course when you take 212, the volume of gas is 0, because it is all water vapor, unless we increase the pressure.

The next column is the change in volume when a given weight of gas is changed from 60° F. to the given temperatures. For instance, at 60° the volume is one. At 120° the volume of the same weight of gas is changed to 1.236, increasing a little less than 24 per cent. At 180°, if you keep the gas saturated, the volume of the same is increased practically two and a half times its volume at 60° F.

The last column is the correction factor of saturated gas for the standard pressure, 30 inches or 14.7 per square inch, and 60° F. temperature.

The other tables from III to XI are all the same, referring to different specific gravities. In these tables all the figures refer to air at 60° F. temperature, and 30 inches barometer. That is, when you have a gas at a specific gravity, say of 60, then in figuring a certain problem, finding out the density of that gas, or the factor to be used for the specific gravity, you have first to find out the same factor for dry air at this temperature, and then apply the specific gravity of the gas and the part of the vapor and that involves a great deal of figuring. In each table the last column gives the figure directly—it gives directly the ratio of the weight per cubic foot of the saturated gas to the weight of air at 60 and 30.

There is another important column in each table designated as the partial gas ratio. The partial gas ratio means the ratio of the weight of the gas alone, not counting the vapor, to dry air at 60 and 30. I have shown how to use this column in the report in connection with flow problems, and it can also be used in connection with other problems in the same way. For instance, when the pressure of saturated gas is increased it does not interfere with the water vapor at all. The water vapor is still the same amount, and the change is going on in the gas only.

Taking this partial gas pressure and by combining, as explained in the paper minutely, the volume factor and the partial gas ratio you get the amount that is to be added for the given pressure to the density or to the specific ratio of the gas. That is, it gives you the additional amount of gas alone for the given pressure, without going into any other calculations, simply by addition.

You will readily see when you go over these tables, that while they were prepared for figuring flow problems they are not limited to these problems alone, and I venture to say that any one who is connected with or interested in the manufacture or distribution of gas, will find it very convenient to have a set of these tables on his desk at all times.

MEASURING FLOW OF UNPURIFIED GASES AT HIGH TEMPERATURES.

This paper brings forth some experimental work on measuring gas products at the outlet of water gas generators, and includes a set of tables giving properties required for determining the flow of saturated gases at various temperatures. The object was to show the advantages to be derived from these measurements, and to give an outline of the work performed in obtaining them.

During this year, experiments were conducted at the Pitney Court Station of the Peoples Gas Light and Coke Company of Chicago on measuring the volume of gases flowing from each individual generator. The device employed consisted of a special Pitot tube inserted in the flow of the gas and connected to a differential gauge indicating the pressure difference created by the flow. The arrangement of the device is shown in Fig. 1. In this case, as can be seen from the figure, there are two points available for measuring the flow of gas from the super-heater before the gas enters the common main; One is at the outlet from the super-heater before the gas enters the wash-box where the average temperature of the flowing gas is about 1,200° F.; and the other is at the outlet from the wash-box where the temperature varies between 180° and 190° F., but where there is a possibility of excessive moisture to be entrained from the wash-box, the distance from the latter being very short in this case.

The practice of determining volumes of flowing gases and liquids from the velocity pressure developed by the impact of the flow has become very general. The relation between the two physical quantities, velocity and pressure, is well known fundamentally, and for any given substance of known density or weight, the velocity and volume of the flow can easily be determined from the given differential pressure. This relation, however, becomes more or less complicated in cases where gases are flowing at high temperatures and where the density and quality of the gas is not uniform. The impact of the flowing mass creating the pressure difference is a complex quantity equivalent to the weight of the following mass, times the square of the velocity. When the differential pressure changes, it indicates that the force of the impact has changed. This may be due, as it is generally inferred, to a change in the velocity of the flowing mass. It may also be due to a change in the density of the gas or to both, change in density and velocity.

These are some of the difficulties anticipated before the experiments were started. It was also feared that Pitot tubes made of ordinary steel tubing would not be strong enough to withstand the temperatures of the hot gases at the outlet of the super-heater. Considering the uncertainties of conditions at the two points where the flow from the individual machine could be measured, it was thought advisable to investigate at both points and to make the first trial on the hot gases in the take-off from the super-heater. Tube No. 1, which is of equal area type, and extends over the entire cross section of the pipe, was installed in the take-off pipe of an 11-foot water gas generator set. The outlet from the tube was connected to a velocity gauge placed on a small board close to the wash-box of the machine. The construction of the tube and the velocity gauge were the same as that given in the first part of last year's report of the Committee on Gas Works Auxiliaries, published in the 1915 *Proceedings* of the American Gas Institute.

This installation proved that the flow of hot gases could be measured in this way. Readings of the velocity gauge have shown consistent variations with the supply of oil and steam to the generator. The high temperature of the gas did not seem to affect the tube or to interfere with the indications of the gauge. It was found, however, that the tube could not be operated continually on account of the carbon accumulating and covering the small openings through which the differential pressure is transmitted to the velocity gauge. In order to keep the device in operation it was found necessary to remove the tubes for cleaning after they have been in operation for 24 hours.

The following table represents a record of the velocity gauge readings with tube No. 1, on No. 9 machine, Pitney Court Station.

Date, Dec. 15, 1915.—Oil per run 75 gallons. Steam per minute 75 pounds. Super-heater temperature 1,330. Readings taken every 20 seconds.

								Steam runs	
Time min.	1 up	2 up	3 down	4 up	5 up	6 up	7 down	down	up
	124	105	90	114	115	118	91	55	74
1	125	118	97	122	112	121	98	50	70
	125	114	94	121	110	117	97	48	68
	123	115	98	125	108	119	95	51	66
2	127	112	99	126	109	121	94	51	64
	125	112	102	124	111	118	97	50	62
	124	110	98	120	108	123	97	49	67
3	117	110	101	117	103	114	92	49	65
	112	112	100	117	112	111	89	48	64
	117	107	60	114	112	108	97	48	63
4	68	103	65	105	70	115	55	46	60
	64	70	62	110	61	65	68	45	60
	62	60	54	61	0	58	64	63	59
5	0	0	0	0	0	0	0	0	50

In this table the readings are the indications of the velocity gauge in units of flow as marked on the scale of the gauge, 100 of the units being equivalent to the impact of a flow of gas balancing 1 inch of water differential head. The table shows merely the relative variation in the quantity of flow during the given runs. For determining the actual amount of gas corresponding to the indications of the gauge,

it would be necessary to ascertain the average temperature and the density of the gas flowing through the pipe where the tubes are inserted. It was decided before going into these details to experiment on the design of a Pitot tube which would be little effected by the impurities in the flowing gases in order to obtain reliable indications at all times.

In Fig. 1, the Pitot tube is shown inserted in the take-off pipe, and the velocity gauge is extended to the gas maker's desk. It was found that at this place the additional length of pipe connections to the gauge did not interfere with the accuracy of the readings. The take-off pipe where the tube was inserted was cleaned to an average diameter of 21 inches. The cast-iron pipe has an inside diameter of 24 inches, but a deposit of 1½ inch thickness was left on the inside to prevent the metal from cracking. The Pitot tube shown extended over the whole cross-section of the pipe is designated as tube No. 1, and is given in greater detail on the next drawing. It was made of ¼-inch standard pipe, and had 30 openings, $^{5}/_{32}$-inch diameter, on each side of the tube. The openings were spaced so as to represent equal sections of flow as explained in last year's report of the Committee on Gas Works Auxiliaries. This tube when removed for cleaning, was covered with a layer of lampblack mainly on the side from the flow. Most of the openings on both sides were closed, and blowing with steam did not remove the whole deposit of carbon from the inside. It was necessary to use an iron rod for removing this deposit.

Tube No. 2 was made of ⅝-inch steel tubing with 24 openings, $^{3}/_{16}$ inch in diameter, in each tube. Two additional tubes were provided on the same fitting, one for taking a sample of the gas, and the other for inserting a fire-end of an electric thermo-couple for measuring the temperature of the gas. This tube developed a differential pressure somewhat lower than tube No. 1 for the same flow on account of the wider obstruction it offered to the flow. Both tubes were being plugged up to the same extent, and so had to be cleaned very often. It was decided to experiment on a single opening tube which should be placed in the center of the pipe. The opening could be made much larger, and it could be easily cleaned by blowing steam through the tube.

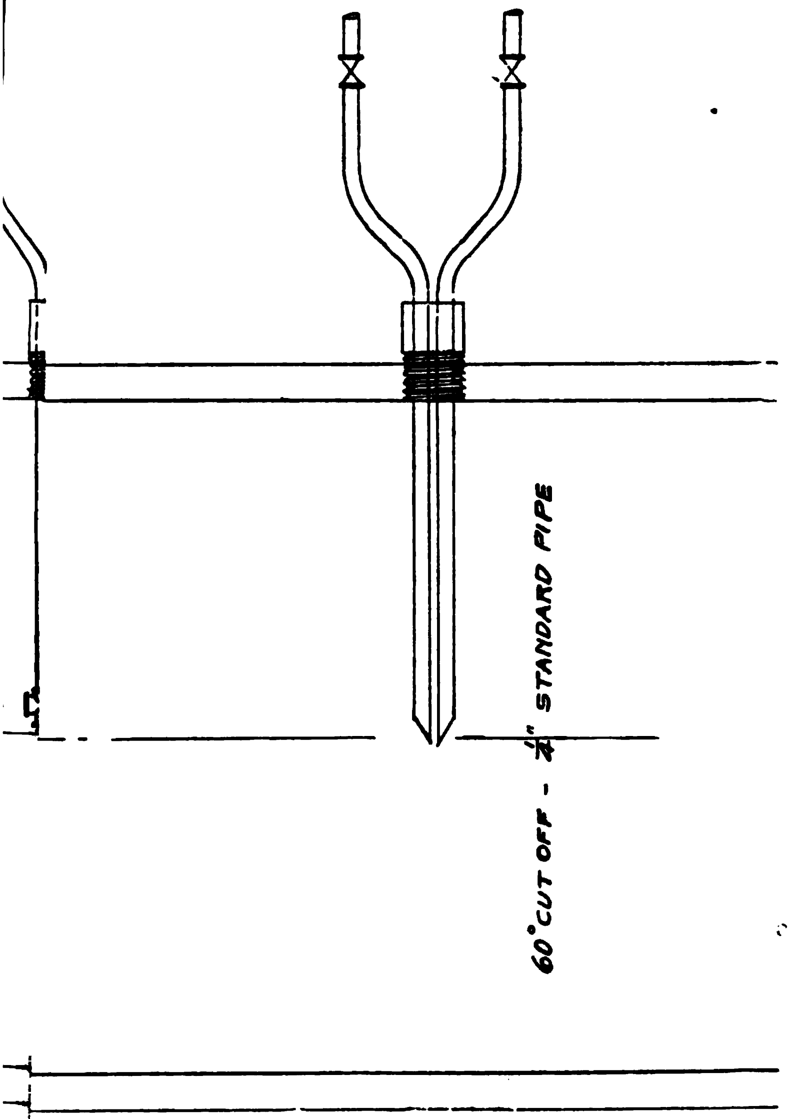
The first of the single opening type was tube No. 3. This tube had two ¼-inch open tees, one facing the flow and one away from the flow. The tees were cut off flush at the open ends. By comparing the readings on equal conditions with the readings of tube No. 1 this tube showed a reduction of about 25 per cent. in the indicated flow units.

Tube No. 4 was made similar to tube No. 3, but the tees were left with full length of nozzles on the open ends. It was found, however, that these tubes with the single openings were also being plugged up with lamp black, and they had to be cleaned by blowing steam through them at frequent intervals. Tube No. 3 was plugged on the rear side only, and, as a trial, it was changed to the shape of tube No. 5, with a straight end on the static side. This, however, did not prevent the static side from being plugged up. The shape of the accumulated carbon in the openings was not the same in all cases.

An attempt was made next to blow out the tubes with steam without removing them from the gas main. For this purpose steam connections were made to the outlets near the velocity gauge, and it was decided to try out tubes of various shapes in order to determine the shape that will stand the longer period of time and give consistent readings of the velocity gauge.

Tube No. 6 has a $^5/_{16}$-inch opening on each side, and tube No. 7 has two 45° angle ells facing in opposite directions. Tube No. 7 was rejected immediately because it gave a low differential reading, and was plugged up even worse than the others.

Tube No. 8 has the ends cut off to a 60° angle from the horizontal. The installation was provided with steam connections near the velocity gauge to blow the tubes without removing them from the gas main. This tube was operating seemingly much better than any other shape under similar conditions. Later the cut-off angle was changed to 70° in-



7

TUBE No 8.

stead of 60°. This kind, designated as tube No. 9, was adapted as the most suitable to the conditions in the take-off pipe. This tube was operating with comparatively little attention but it was necessary to blow it out with steam several times daily. Sometimes it was even necessary to remove the tube and clean it out mechanically.

With this tube in operation in the take-off pipe, a similar one was inserted at the outlet from the wash-box in the horizontal piece running between the bend and the valve as shown on Fig. 1. Having two gauges in operation on the same machine, one at the outlet from the super-heater and the other at the outlet from the wash-box, a test was made during a number of runs to determine the comparative value of the indications of the two gauges. The results of the test are shown on the accompanying charts in comparative units of flow, representing the per cent. of variation and not the actual volume of the gases. The test covers the following conditions of operation:

Chart No. 1: Steam in-put, 100 pounds per minute; oil, 27 gallons per minute. The rate of flow from the super-heater is shown in two forms: One curve shows the number of flow units actually indicated by the velocity gauge; a second curve shows the number of flow units that would result if the same volume of gases were reduced to the temperature of the wash-box; a third curve shows the number of flow units that was indicated by the gauge connected to the flow from the wash-box; the horizontal line covering the oil period of the chart shows the flow that would result from the wash-box for complete decomposition of the steam and the oil.

The shape of the curves, declining from the very start of the run, indicate that the supply of steam is excessive and that the operation is not economical for the given condition of the fuel. It shows that the same rate of oil supply produced 60 flow units at the outlet from the wash-box at the beginning and only 50 units at the end of the run. The flow from the super-heater drops from 117 to 90 units, which shows a reduced decomposition of the water vapors. The ratio of total decomposition of the steam and the oil is 63.5 per cent.

Chart No. 2: The oil was supplied with the same rate of 27 gallons per minute but the steam was reduced to 95 pounds. This small change is noticed on the shape of the curves declining over a shorter distance than in Chart No. 1. The ratio of decomposition of the steam and the oil is 63.5 per cent., the same as before.

Chart No. 3: The steam was reduced to 74 pounds per minute, the oil being the same 27 gallons per minute. It will be noticed that the rate of flow is nearly the same until the end of the oil period, and the ratio of decomposition of the steam and the oil is increased to 71.5 per cent.

Chart No. 4: The steam was supplied at the same rate of 74 pounds, but the oil was reduced to 22 gallons. The shape of the curves is about the same as in chart No. 2, only the make was reduced with the reduction of the oil. The ratio of decomposition of the steam and the oil is reduced to 70.5 per cent.

Chart No. 5: The oil was reduced to 18.5 gallons per minute, the steam being the same, 74 pounds. This increased the ratio of decomposition of the steam and the oil to 71.5 per cent.

Chart No. 6 shows a comparison of 1, 2, and 3, in which the steam was varied with a constant supply of oil.

Chart No. 7 shows a comparison of 3, 4, and 5, in which the oil was varied with constant supply of steam. It will be noticed that the reduction of oil from 22 to 18.5 gallons did not reduce the rate of flow from the wash-box. It increased the ratio of decomposition of the steam and the oil, which either shows that less condensation took place or that the oil was over-cracked.

Chart No. 8 shows a typical trial on a down-run. The steam input was only 60 pounds per minute and the oil 27 gallons. The rate of flow is the same for the whole oil period, and the ratio of decomposition of the steam and the oil is 72 per cent.

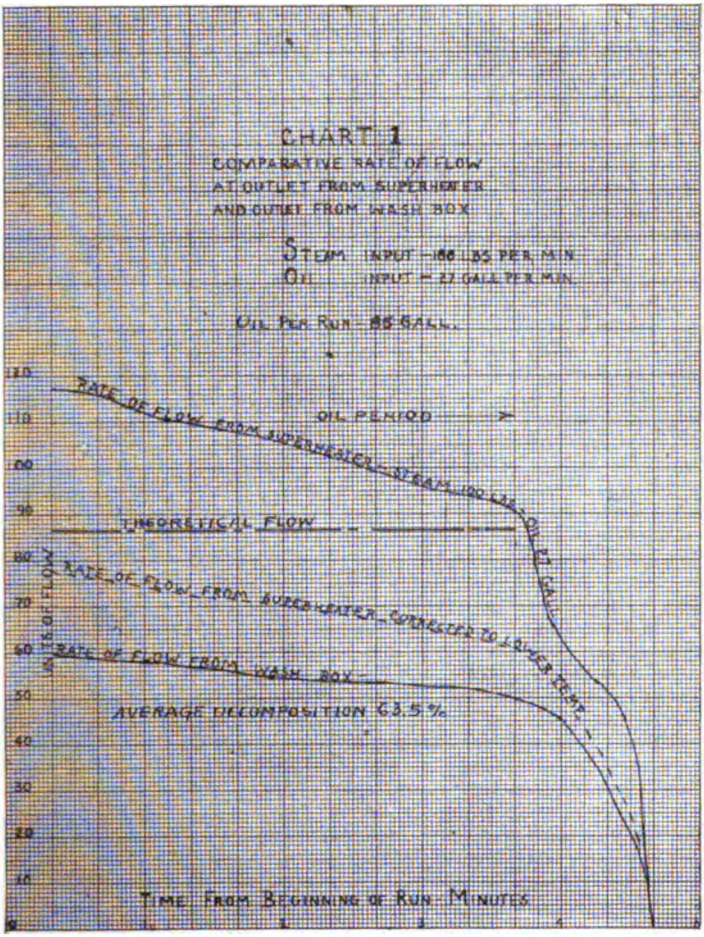


CHART 1
COMPARATIVE RATE OF FLOW
AT OUTLET FROM SUPERHEATER
AND OUTLET FROM WASH BOX
STEAM INPUT - 100 LBS PER MIN
OIL INPUT - 27 GALL PER MIN
OIL PER RUN - 85 GALL.
OIL PERIOD
RATE OF FLOW FROM SUPERHEATER - STEAM 100 LBS - OIL 27 GALL
THEORETICAL FLOW
RATE OF FLOW FROM SUPERHEATER CORRECTED TO LOWER TEMP.
RATE OF FLOW FROM WASH BOX
AVERAGE DECOMPOSITION 63.5 %
UNITS OF FLOW
120
110
100
90
80
70
60
50
40
30
20
10
0
1
2
3
4
5
TIME FROM BEGINNING OF RUN MINUTES

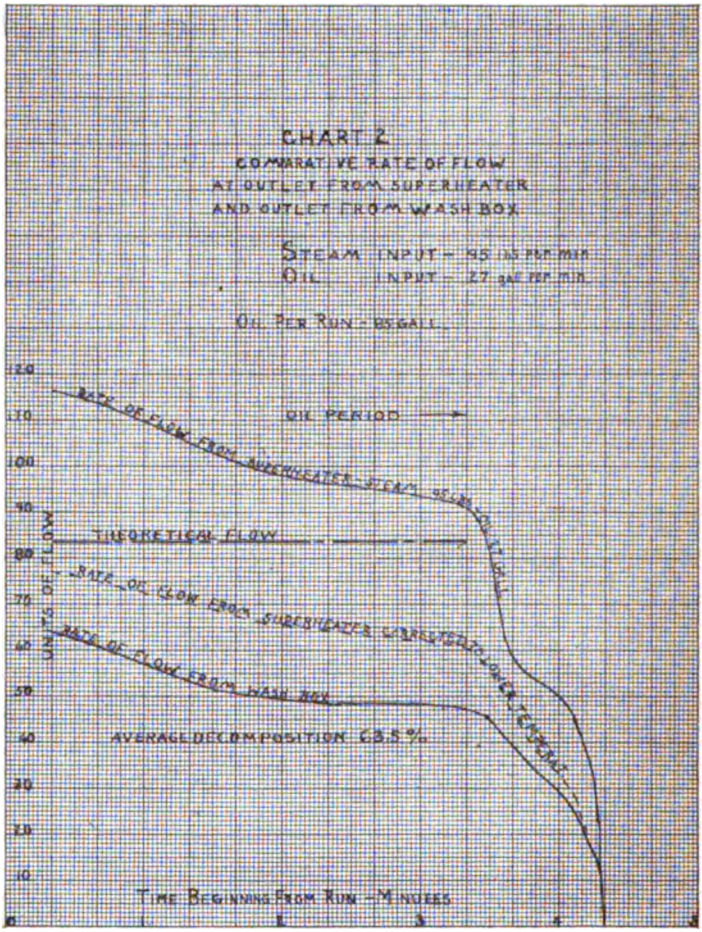


CHART 2
COMPARATIVE RATE OF FLOW
AT OUTLET FROM SUPERHEATER
AND OUTLET FROM WASH BOX
STEAM INPUT - 95 lbs per min
OIL INPUT - 27 gal per min
OIL PER RUN - 85 GALL.
OIL PERIOD
RATE OF FLOW FROM SUPERHEATER - STEAM 95 LBS OIL 27 GALL
THEORETICAL FLOW
RATE OF FLOW FROM SUPERHEATER CORRECTED TO LOWER TEMPERATURE
RATE OF FLOW FROM WASH BOX
AVERAGE DECOMPOSITION 63.5 %
UNITS OF FLOW
120
110
100
90
80
70
60
50
40
30
20
10
TIME BEGINNING FROM RUN - MINUTES
0
1
2
3
4
5

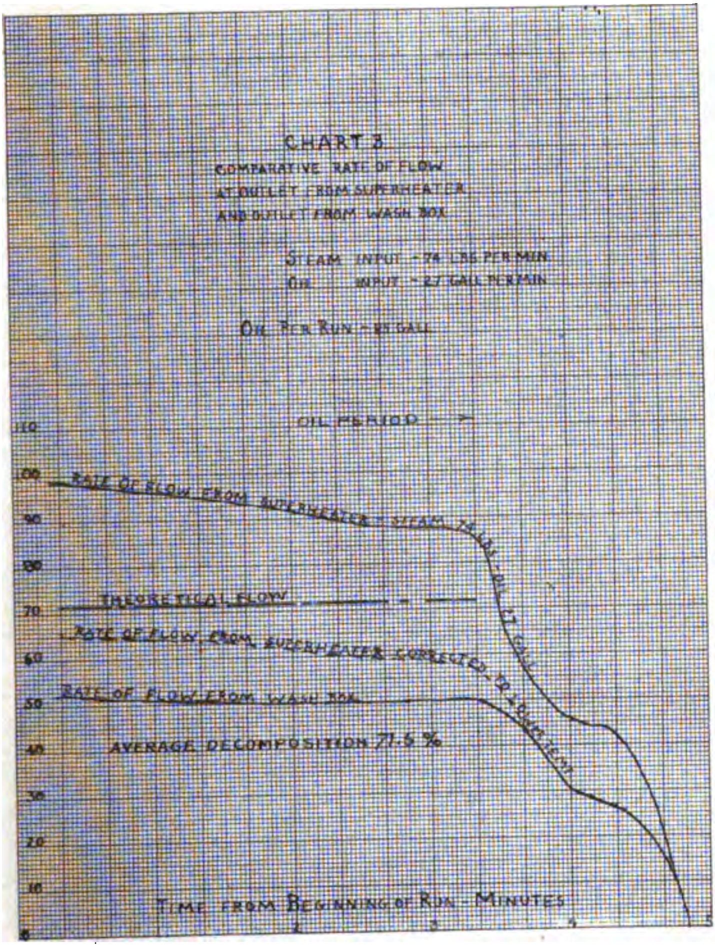


CHART 3
COMPARATIVE RATE OF FLOW
AT OUTLET FROM SUPERHEATER
AND OUTLET FROM WASH BOX
STEAM INPUT – 74 LBS PER MIN
OIL INPUT – 27 GALL PER MIN
OIL PER RUN – [illegible] GALL
OIL PERIOD →
RATE OF FLOW FROM SUPERHEATER = STEAM 74 LBS + OIL 27 GALL
THEORETICAL FLOW
RATE OF FLOW FROM SUPERHEATER CORRECTED TO [illegible]
RATE OF FLOW FROM WASH BOX
AVERAGE DECOMPOSITION 71.5 %
TIME FROM BEGINNING OF RUN – MINUTES
110
100
90
80
70
60
50
40
30
20
10
0
2
3
4
5

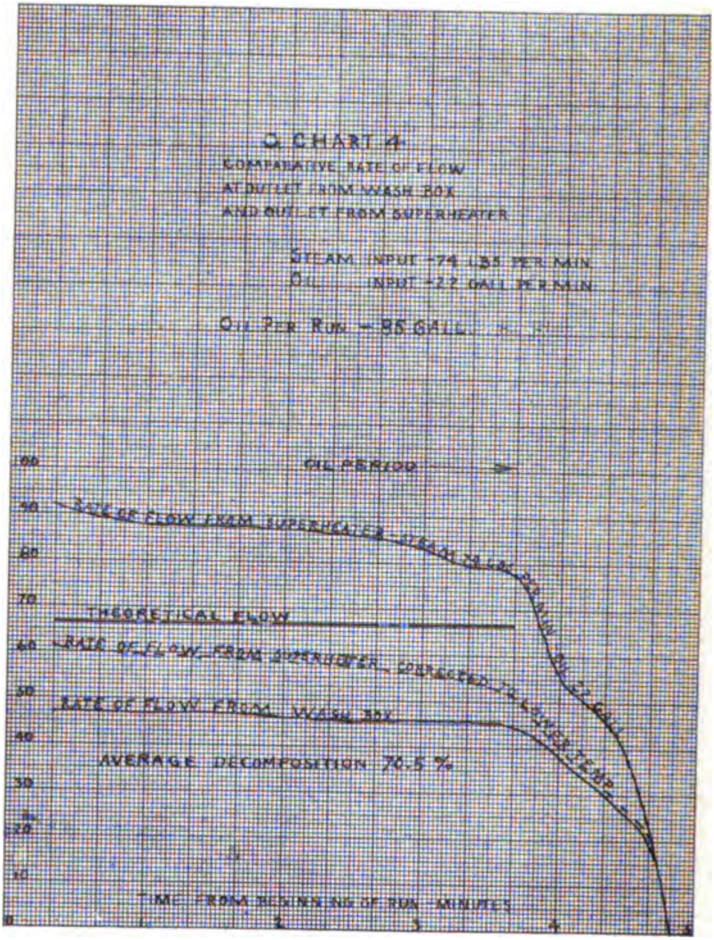


CHART 4
COMPARATIVE RATE OF FLOW
AT OUTLET FROM WASH BOX
AND OUTLET FROM SUPERHEATER
STEAM INPUT 74 LBS PER MIN
OIL INPUT 22 GALL PER MIN
OIL PER RUN – 85 GALL
OIL PERIOD
RATE OF FLOW FROM SUPERHEATER – STEAM 74 LBS PER MIN OIL 22 GALL
THEORETICAL FLOW
RATE OF FLOW FROM SUPERHEATER CORRECTED TO LOWER TEMP
RATE OF FLOW FROM WASH BOX
AVERAGE DECOMPOSITION 70.5 %
100
90
80
70
60
50
40
30
20
10
0
1
2
3
4
5
TIME FROM BEGINNING OF RUN – MINUTES

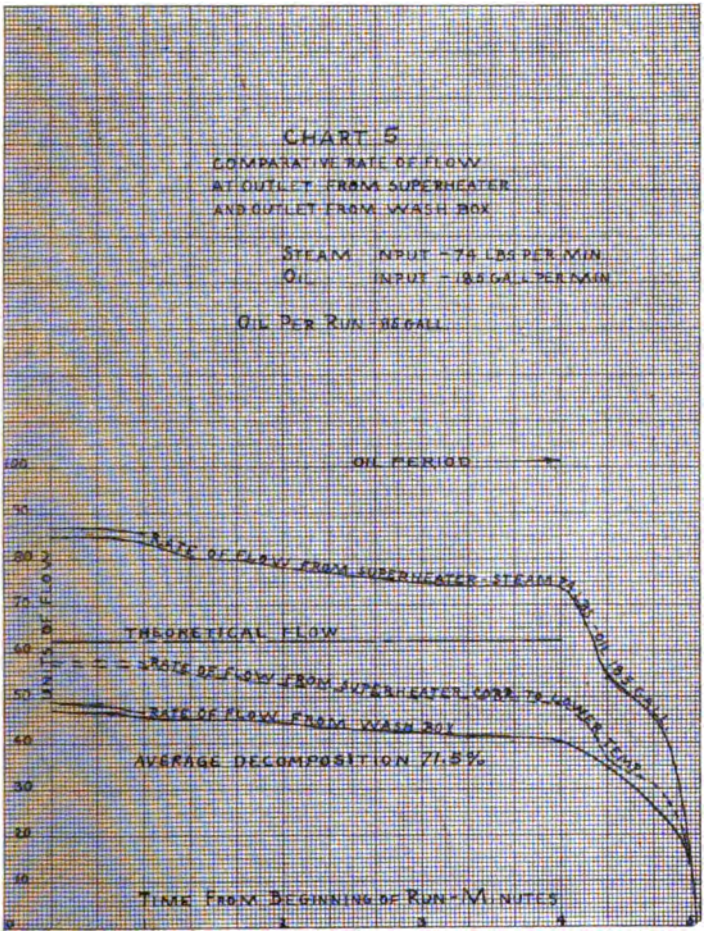


CHART 5
COMPARATIVE RATE OF FLOW
AT OUTLET FROM SUPERHEATER
AND OUTLET FROM WASH BOX
STEAM INPUT - 74 LBS PER MIN
OIL INPUT - 185 GALL PER MIN
OIL PER RUN - 86 GALL
OIL PERIOD
RATE OF FLOW FROM SUPERHEATER - STEAM 74 LBS. OIL 185 GALL
THEORETICAL FLOW
RATE OF FLOW FROM SUPERHEATER CORR TO LOWER TEMP
RATE OF FLOW FROM WASH BOX
AVERAGE DECOMPOSITION 71.5%
UNITS OF FLOW
100
90
80
70
60
50
40
30
20
10
TIME FROM BEGINNING OF RUN - MINUTES
0
2
3
4
5

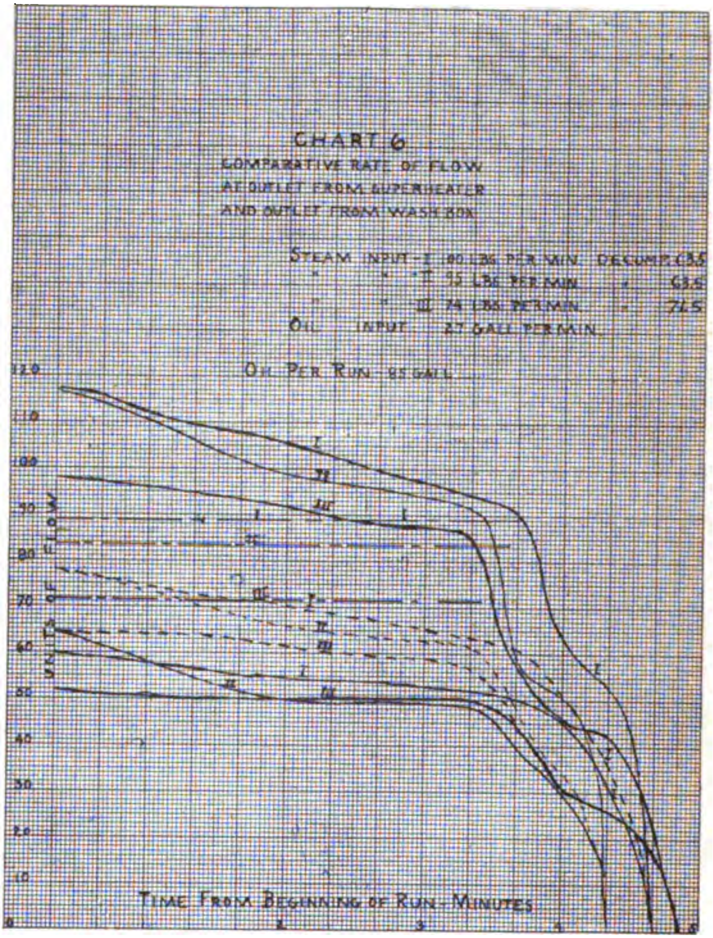


CHART 6
COMPARATIVE RATE OF FLOW
AT OUTLET FROM SUPERHEATER
AND OUTLET FROM WASH BOX

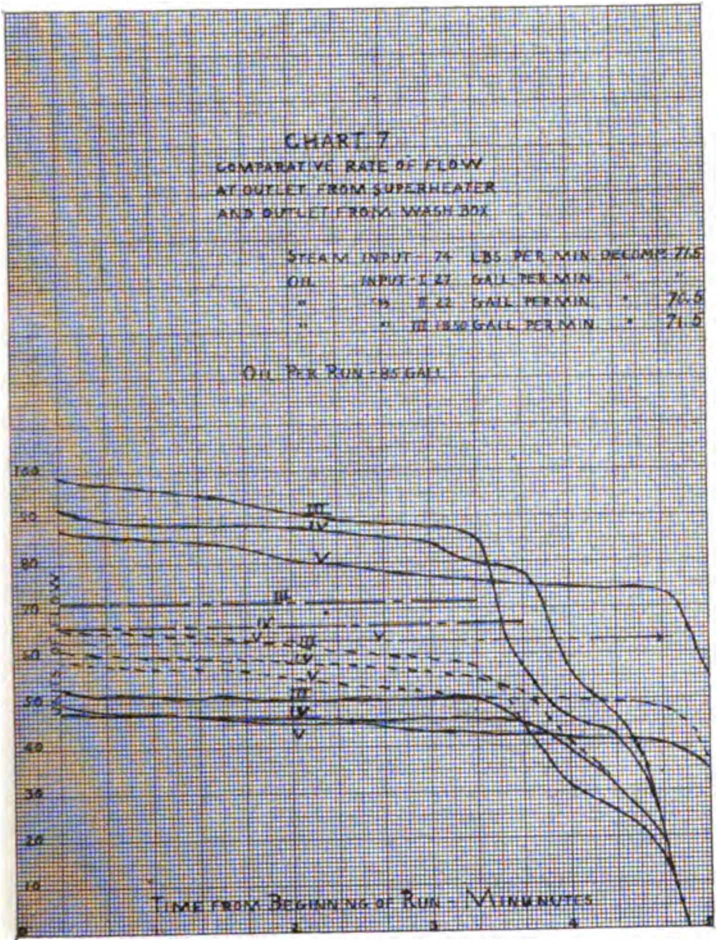


CHART 7

COMPARATIVE RATE OF FLOW AT OUTLET FROM SUPERHEATER AND OUTLET FROM WASH BOX

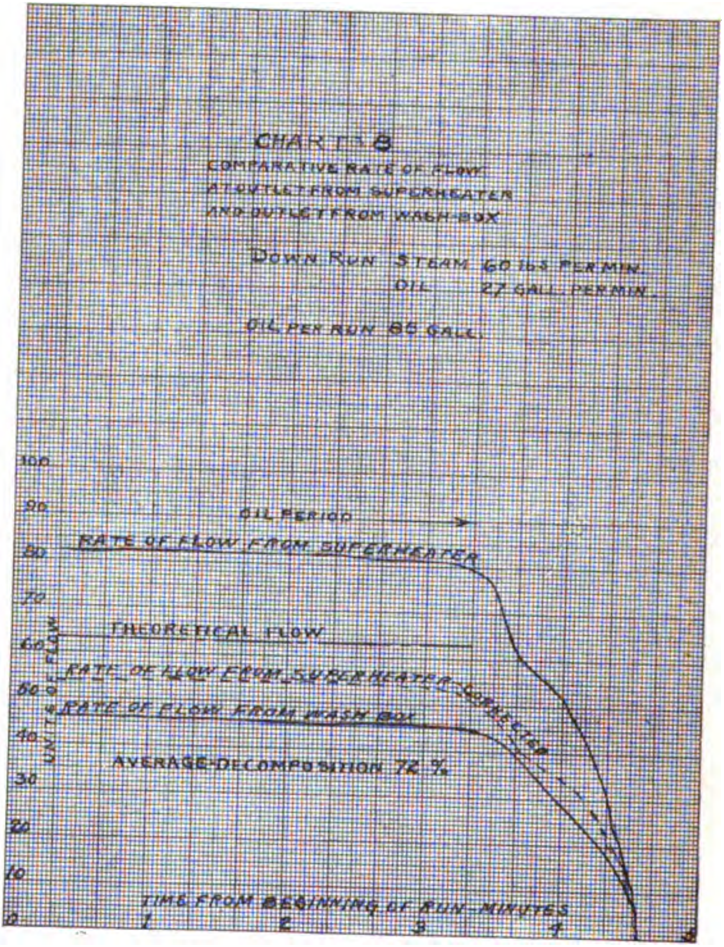


CHART 8
COMPARATIVE RATE OF FLOW
AT OUTLET FROM SUPERHEATER
AND OUTLET FROM WASH-BOX
DOWN RUN STEAM 60 lbs PER MIN.
OIL 27 GALL. PER MIN.
OIL PER RUN 86 GALL.
OIL PERIOD
RATE OF FLOW FROM SUPERHEATER
THEORETICAL FLOW
RATE OF FLOW FROM SUPERHEATER CORRECTED
RATE OF FLOW FROM WASH BOX
AVERAGE DECOMPOSITION 72 %
UNITS OF FLOW
100
90
80
70
60
50
40
30
20
10
0
TIME FROM BEGINNING OF RUN - MINUTES
1
2
3
4
5

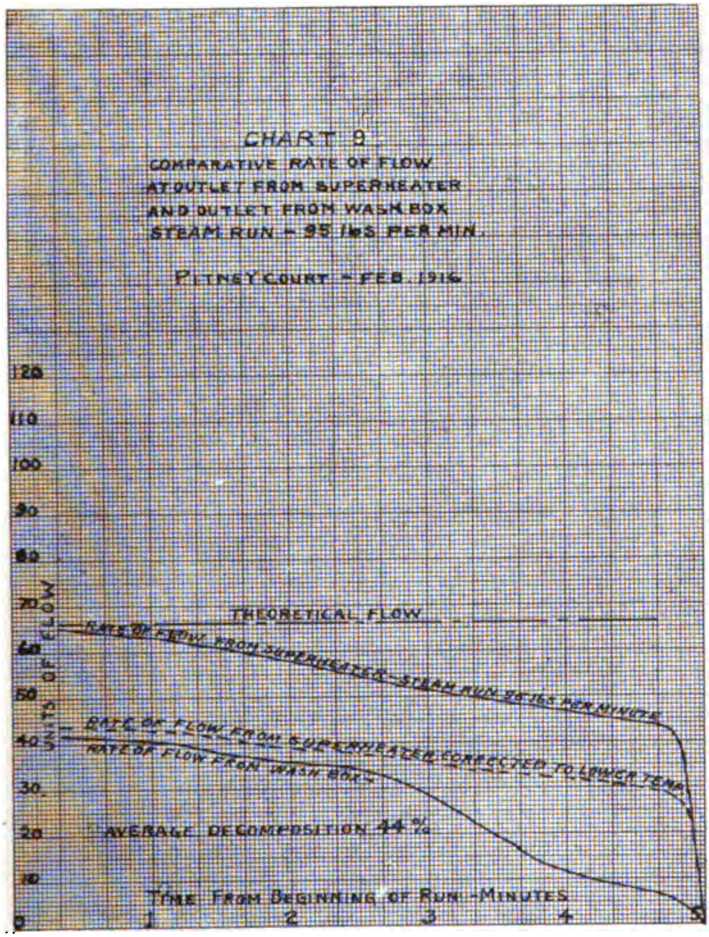


CHART 9.
COMPARATIVE RATE OF FLOW
AT OUTLET FROM SUPERHEATER
AND OUTLET FROM WASH BOX
STEAM RUN – 95 lbs PER MIN.

PITNEY COURT – FEB. 1916

Chart No. 9 is a typical steam run, showing the effect of a high steam rate and length of run. It will be noticed that after the third minute the rate of flow from the wash-box is greatly reduced, while the rate of flow from the super-heater is not changed materially. This shows that the increased amount of steam produced water vapors at the end of the run which were condensed in the wash-box. The ratio of decomposition of the steam is 44 per cent.

While these indications are only comparative, they are sufficient to show the advantages that can be derived from this device in regulating the operation of the water gas set. From the analysis of these results and the comparison of the various indications, we come to the conclusion that the proper place for indicating the flow of the machine is at the outlet of the wash-box. These conclusions were substantiated by similar experiments that are being conducted at the Fulton Works of the Brooklyn Union Gas Company. Following is a summary of the work as given by Mr. Schaaf who is conducting the experiments at that station.

The Pitot tube used in this case was of the equal area type, made of ¼-inch tubing with eight openings drilled on each side. The openings were spaced according to the formula,

$$r = R\sqrt{\frac{2a - 1}{N}}$$

where r = the distance of the given opening from the center of the pipe.

R = the radius of the pipe in which the flow is measured.

a = the number of the opening from the center of the pipe.

N = the total number of openings in the tube.

The tube was inserted in the take-off pipe between the wash-box and the trunk main, and was connected to a water gauge located about 2 feet above the tube. The arrangement is shown on Fig. 2. It will be noticed that in this instance the location of the tube was very favorable, having about 20 feet

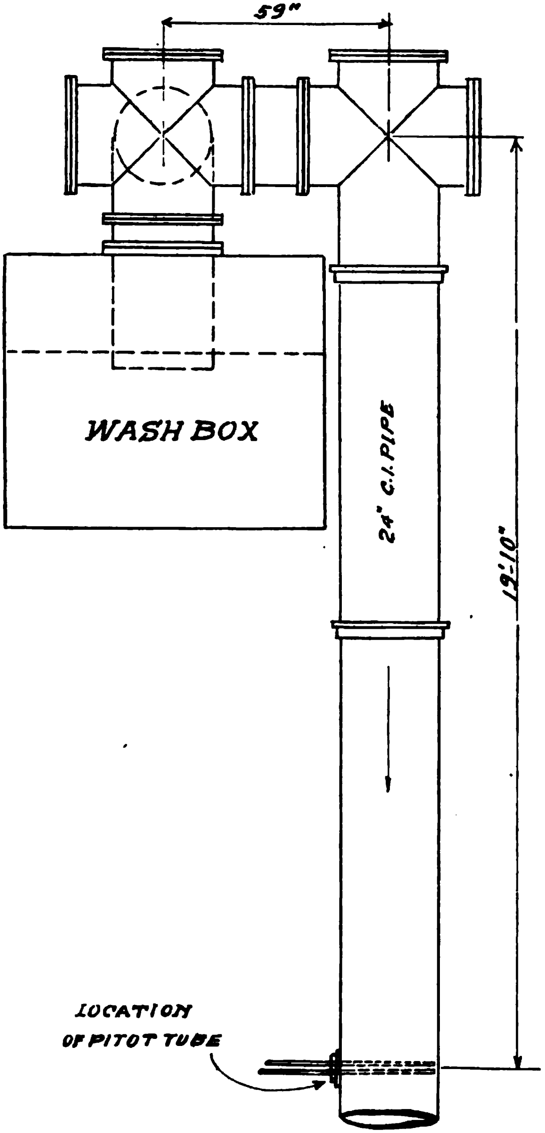


FIG. 2.

of straight pipe in front of the tube, against 2 or 3 feet in the Pitney Court experiments.

Due to the favorable location of the tube, the differential pressure developed indicated very closely the actual volume of gas flowing through the pipe. The following table shows a comparative test of the Pitot tube indications against readings of the station meter:

CHECKING PITOT TUBE IN TAKE OFF AGAINST STATION METER

Date	Time	Run No.	Min. of run in hour	Average make per minute	Make per run	Meter make
Feb. 29	11 A. M.	38	2	4,080	8,160	
	to	39	4	4,170	16,680	
	12 Noon	40	4	4,330	17,320	
		41	4	4,570	18,280	
		42	4	4,930	19,720	
		43	4	4,410	17,640	
		44	4	4,590	18,360	
					116,160	119M
Mar. 1	11 A. M.	39	4	4,240	16,960	
	to	40	4	4,040	16,160	
	12 Noon	41	4	4,120	16,480	
		42	6	4,210	25,260	
		43	4	4,110	16,440	
		44	4	3,820	15,280	
					106,580	118M
Mar. 2	11 A. M.	38	1	4,080	4,080	
	to	39	4	4,550	18,200	
	12 Noon	40	4	4,330	17,320	
		41	6	4,570	27,420	
		42	4	4,560	18,240	
		43	4	4,520	18,080	
		44	4	4,600	16,400	
					121,740	111M
Mar. 3	11 A. M.	40	4	4,410	17,640	
	to	41	4	4,220	16,880	
	12 Noon	42	4	4,220	16,880	
		43	6	4,330	25,980	
		44	4	4,250	17,000	
		45	4	4,330	17,320	
		46	3	4,170	12,510	
					124,210	128M

		Make per hour	Meter make
Feb. 29	11 A. M. to 12 Noon	116,160	119M
Mar. 1	11 A. M. to 12 Noon	106,580	118M
Mar. 2	11 A. M. to 12 Noon	121,740	111M
Mar. 3	11 A. M. to 12 Noon	124,210	128M
	Total	468,690	476M

Pitot tube readings low by 7.31 M cubic feet or 1.54 per cent.

In comment on the results Mr. Schaaf says: "This tube was inserted in the take-off pipe between the wash-box and the trunk main and connected to a gauge located about 2 feet above the tube. It has been found that, due to the occillating columns, a long length of pipe is undesirable.

"Care should be taken in reading, since the occillations caused by the water in the wash-box tend to give high values. There is sufficient time to read when the columns are steady. Readings were taken every 15 seconds and care was exercised to get an average of the movement of the column for each interval.

"The table shows that the results are sufficiently accurate for watching the performance of machines; and over a long period of time this method of measurement will no doubt give very accurate results for all practical purposes, since the errors of reading equalize.

"The makes as given in the table were not computed individually but were taken from a curve based on an average barometer, static pressure, and temperature."

In the Pitney Court experiments the tubes were located close to right angle bends. At the outlet from the wash-box, the flow was searched with an adjustable tube of type 9 across the diameter of the 24-inch pipe and it was found that the maximum velocity occurred 4½ inches from the wall opposite the bend. At this station four 11-foot machines are now equipped with Pitot tubes at the outlet from the wash-box, the arrangement being similar to that shown in Fig. 1. The openings of the tubes are set at the point of maximum flow in each case. This results in higher reading of the gauges and allows more accurate computations of the volume of gas corresponding to the flow units indicated by the velocity gauges. These gauges are placed on the gas maker's desk.

The gases flowing from the wash-box are necessarily saturated with water and oil vapors at the given temperature of the gas. These have to be taken into consideration in computing the volume of the flow corresponding to the velocity pressure indicated by the differential gauge. The oil vapors form a small quantity and may be neglected. The water vapors, however, form the major part of the flow at the usual temperatures of the gases at the outlet of the wash-box, and therefore the computation of the velocity equivalent to a given differential pressure developed by the impact of the flow requires the use of tables showing the weights and partial pressures of saturated water vapors. The general steam tables or the hygrometric tables do not give directly the information necessary for figuring flow problems of saturated gases, and therefore the process of computing the velocity involves a great deal of laborious calculations.

To facilitate this work it was found necessary first, to work out a standard formula for figuring the flow of saturated gases, and second, to prepare a set of tables giving the properties of saturated gases, required in figuring flow problems.

The tables are attached to this paper and they include the following information: Table I gives the general properties of dry air from zero to 212° F. and also the pressure and density of saturated water vapor. This table was used as the base from which the figures of all the other tables were computed.

Table II gives the properties and correction factor of saturated gases. This correction factor is independent of the specific gravity of the gas and can be used directly for correcting volumes of saturated gases, at the given temperatures between zero and 212° at 30 inches absolute pressure.

Tables III to XI, inclusive, give the factors prepared for determining the ratio of the density of atmospheric air at the given temperatures, and of gases from 0.75 to 0.40 specific gravity, to the density of dry air at 60° F. temperature and 30 inches absolute pressure. This "specific ratio" is substituted for the specific gravity of the gas in computing the volume of the flow. The tables also contain the densities of the gases at the given temperatures. The use of the tables in connection with this work will be demonstrated in the following:

It can be shown that the theoretical rate of flow of gas corresponding to a given differential pressure, developed by the impact of the flow is given by the following equation:

$$Q = 5.2\, C\, d^2 \sqrt{\frac{460 + t_1}{SB_1}} \sqrt{H}$$

In this equation,

Q is the quantity of gas in cubic feet per minute, flowing through the pipe at the given temperature t_1 and pressure B_1.

d is the diameter of the pipe in inches.

t_1 is the temperature of the gas in degrees Fahrenheit.

S is the specific gravity of the gas as referred to air.

B_1 is the absolute pressure in the pipe, inches of mercury.

H is the differential head in inches of water.

C is a numerical coefficient depending upon the shape of Pitot tube used.

(For the derivation of the formula see "Methods and Facilities," by J. M. Spitzglass, *Proceedings* of the American Gas Institute, vol. IX, part 1, p. 615.)

For the purpose of computing the flow of saturated gases, it was convenient to reduce this equation to a form covering the flow of gases at standard conditions of 30 inches pressure and 60° F. temperature.

The substitution of 30 and 60 in the above equation takes the form of

$$Q = 21.7\, C\, d^2 \sqrt{\frac{H}{S}}$$

with notation as above.

With this form as a standard it is necessary to determine the value of S, which is the ratio of the density of the saturated gas at the given pressure, temperature and degree of saturation, to the density of air at 60° F.

In any given problem of this kind it is convenient to proceed in the following order, referring to the accompanying tables.

First: Determine the value of S, or the specific ratio of the gas at the given conditions. If the gas is flowing at a pressure of 30 inches of mercury, or approximately 14.7 pounds per square inch absolute the value of S corresponding to the given temperature of the gas is taken directly from the "Specific Ratio" column of the table marked for the given specific gravity of the gas. If the flow is saturated with water vapor at any other pressure, B_1 inches of mercury, or P_1 pounds per square inch absolute, the value of S is obtained by the formula:

$$S = \frac{B_1 - 30}{30} \times \text{volume factor} + \text{specific ratio, or,}$$

$$S = \frac{P_1 - 1.47}{14.7} \times \text{volume factor} + \text{specific ratio.}$$

Second: Multiply the square root of the differential pressure divided by the specific ratio, $\left(\sqrt{\frac{H}{S}}\right)$, by the quantity, $21.7\ Cd^2$, which is a constant for any given size of pipe and kind of tube used. The product will be the number of cubic feet per minute at the actual conditions of the flow.

Third: Determine correction factor for the given conditions of the flow. If the gas is flowing at a pressure of 30 inches, or 14.7 pounds gauge approximately, the correction factor corresponding to the temperature is taken directly from the last column of Table II, for all saturated gases. If the flow is saturated with water vapor at any other pressure, the correction factor is obtained by the formula:

$$\text{Correction factor} = \frac{\frac{B_1 - 30}{30} \times \text{volume factor} + \text{partial gas factor}}{\text{Partial gas factor at } 60^\circ \text{ F.}}$$

or, correction factor =

$$\frac{\frac{P_1 - 14.7}{14.7} \times \text{volume factor} + \text{partial gas factor}}{\text{Partial gas factor at } 60^\circ \text{ F.}}$$

Fourth: Multiply actual cubic feet per minute by correction factor and obtain amount corrected to standard conditions of 60° F. temperature and 30 inches barometric pressure.

Example 1. Flow of gas saturated with water vapor at a pressure of 30 inches of mercury.

Given:

Diameter of pipe (d) = 24 inches.

Pitot tube coefficient (C) = 0.80.

Temperature of flow (t_1) = 185° F.

Differential pressure (H) = 1.2 inches of water.

Specific gravity of gas = 0.65; air = 1.

First: From the specific ratio column of Table VI (0.65 specific gravity) S = 0.514 at 185° temperature.

Second:

$$Q = 21.7 \times 0.80 \times (24)^2 \sqrt{\frac{1.2}{0.514}}$$

$$= 9{,}999\sqrt{\frac{1.2}{0.514}} = 15{,}270$$ cubic feet of gas per minute at the actual conditions of the gas in the pipe.

Third: From Table II, correction factor of saturated gas at 185° F. is 0.353.

Fourth: 15,270 × 0.353 = 5,370 cubic feet per minute corrected to standard conditions of 60 and 30.

Example 2: Flow of saturated gas at 1.5 pounds gauge pressure; other conditions the same as in Example 1.

First:

$$S = \frac{1.5}{14.7} \times 0.807 + 0.514 = 0.596$$

Second:

$$Q = 9{,}999 \sqrt{\frac{1.2}{0.596}} = 14{,}180 \text{ cubic feet per minute}$$

at actual conditions.

Third:

$$\text{Correction factor} = \frac{\frac{1.5}{14.7} \times 0.807 + 0.224}{63.9} = 0.478$$

Fourth:

14,180 x 0.478 = 6,800 cubic feet per minute corrected to standard conditions of 60 and 30.

It will be observed that the tables contain additional gas properties and they can be utilized for various other purposes, as for instance in determining the carrying capacity of pipes for saturated gases. The tables can also be applied to conditions of partial saturation. In all cases the object is, first, to find the specific ratio of the gas at the given condition, and second, to find the corresponding correction factor as outlined in the given examples.

It is hoped that with the aid of these tables, and the given outline of the work, the measurement of saturated gases at higher temperatures will be much simplified, and will be applied more conveniently for the efficient operation of the gas works.

TABLE I.—PROPERTIES OF DRY AIR AND OF SATURATED WATER VAPOR.

(At 30 inches Barometric Pressure.)

Temperature degrees F.	Cu. ft of dry air in one lb.	Density lbs. per cu. ft.	Volume factor to 60° F.	Press. of water vapor lbs. per sq. in.	Density of water vapor lbs. per cu. ft.
0	11.581	0.08635	1.130	0.0216	0.000081
10	11.833	0.08451	1.106	0.0339	0.000130
20	12.085	0.08275	1.083	0.0525	0.000195
30	12.337	0.08106	1.061	0.0758	0.000281
32	12.387	0.08073	1.057	0.0886	0.000304
40	12.589	0.07944	1.040	0.1217	0.000410
45	12.715	0.07865	1.030	0.1475	0.000492
50	12.841	0.07788	1.019	0.1780	0.000587
55	12.967	0.07712	1.009	0.2140	0.000700
60	13.093	0.07638	1.000	0.2562	0.000828
65	13.219	0.07565	0.991	0.3054	0.000977
70	13.345	0.07494	0.982	0.3626	0.001148
75	13.471	0.07424	0.972	0.4288	0.001346
80	13.597	0.07355	0.963	0.505	0.001570
85	13.722	0.07287	0.954	0.594	0.001832
90	13.849	0.07221	0.946	0.696	0.002131
95	13.974	0.07156	0.937	0.813	0.002469
100	14.100	0.07092	0.929	0.946	0.002851
105	14.227	0.07029	0.921	1.098	0.003282
110	14.353	0.06967	0.913	1.271	0.003766
115	14.479	0.06907	0.905	1.467	0.004312
120	14.605	0.06847	0.897	1.689	0.004924
125	14.730	0.06788	0.889	1.938	0.005605
130	14.856	0.06730	0.882	2.219	0.006370
135	14.983	0.06674	0.874	2.533	0.007210
140	15.109	0.06619	0.867	2.885	0.008140
145	15.234	0.06564	0.860	3.277	0.009180
150	15.361	0.06510	0.853	3.714	0.010320
155	15.487	0.06457	0.846	4.199	0.011570
160	15.612	0.06405	0.839	4.737	0.012960
165	15.739	0.06354	0.832	5.333	0.014480
170	15.865	0.06303	0.826	5.992	0.016140
175	15.991	0.06254	0.819	6.714	0.017960
180	16.117	0.06205	0.813	7.510	0.019940
185	16.243	0.06157	0.807	8.380	0.022100
190	16.369	0.06109	0.800	9.340	0.024400
195	16.495	0.06062	0.794	10.390	0.027000
200	16.621	0.06016	0.788	11.520	0.029760
205	16.747	0.05971	0.782	12.770	0.032760
210	16.873	0.05927	0.776	14.130	0.035970
212	16.923	0.05909	0.774	14.700	0.037320

TABLE II.—PROPERTIES AND CORRECTION FACTOR OF SATURATED GASES.

(At 30 inches Barometric Pressure.)

Temperature degrees F.	Partial gas pressure lbs. per sq. inch	Proportion of dry gas in mixture	Change in volume from 60° F.	Correction factor to 60° F.
0	14.6784	0.998	0.870	1.149
10	14.6661	0.997	0.880	1.123
20	14.6475	0.996	0.910	1.098
30	14.6242	0.995	0.931	1.075
32	14.6114	0.994	0.935	1.069
40	14.5783	0.992	0.953	1.050
45	14.5525	0.990	0.963	1.038
50	14.5220	0.988	0.976	1.025
55	14.4860	0.986	0.988	1.012
60	14.4438	0.983	1.000	1.000
65	14.3946	0.980	1.012	0.988
70	14.3374	0.976	1.025	0.975
75	14.2712	0.972	1.040	0.961
80	14.1950	0.967	1.056	0.947
85	14.1060	0.961	1.073	0.932
90	14.0040	0.954	1.091	0.916
95	13.8870	0.946	1.111	0.900
100	13.7540	0.937	1.131	0.884
105	13.6020	0.927	1.153	0.867
110	13.4290	0.915	1.178	0.849
115	13.2330	0.900	1.205	0.830
120	13.0110	0.883	1.236	0.809
125	12.7620	0.865	1.272	0.786
130	12.4810	0.846	1.312	0.762
135	12.1670	0.825	1.357	0.737
140	11.8150	0.802	1.409	0.710
145	11.4230	0.777	1.471	0.680
150	10.9860	0.728	1.543	0.648
155	10.5010	0.714	1.626	0.615
160	9.9630	0.678	1.727	0.579
165	9.3670	0.638	1.852	0.540
170	8.7080	0.593	2.008	0.498
175	7.9860	0.544	2.208	0.453
180	7.1900	0.489	2.469	0.405
185	6.3200	0.430	2.825	0.353
190	5.3600	0.365	3.367	0.297
195	4.3100	0.293	4.219	0.237
200	3.1800	0.216	5.747	0.173
205	1.9300	0.131	9.524	0.105
210	0.5700	0.039	32.550	0.031
212	0.0000	0.000	0.000	0.000

TABLE III.—FACTORS FOR ATMOSPHERIC AIR.

Temperature degrees F.	Volume factor	Partial gas density	Partial gas ratio	Total density	Specific ratio
0	1.130	0.08630	1.129	0.08633	1.130
10	1.106	0.08440	1.104	0.08448	1.106
20	1.083	0.08254	1.081	0.08268	1.084
30	1.061	0.08065	1.056	0.08088	1.060
32	1.057	0.08030	1.051	0.08060	1.055
40	1.040	0.07890	1.033	0.07931	1.038
45	1.030	0.07795	1.021	0.07844	1.027
50	1.019	0.07700	1.008	0.07759	1.016
55	1.009	0.07600	0.996	0.07670	1.005
60	1.000	0.07500	0.982	0.07582	0.993
65	0.991	0.07400	0.969	0.07498	0.982
70	0.982	0.07300	0.957	0.07415	0.972
75	0.972	0.07200	0.943	0.07335	0.961
80	0.963	0.07100	0.930	0.07257	0.951
85	0.954	0.07000	0.917	0.07183	0.941
90	0.946	0.06885	0.902	0.07098	0.930
95	0.937	0.06760	0.886	0.07007	0.918
100	0.929	0.06635	0.869	0.06920	0.906
105	0.921	0.06650	0.851	0.06828	0.894
110	0.913	0.06360	0.834	0.06739	0.883
115	0.905	0.06220	0.814	0.06651	0.871
120	0.897	0.06065	0.795	0.06557	0.859
125	0.889	0.05895	0.773	0.06455	0.846
130	0.882	0.05715	0.748	0.06352	0.832
135	0.874	0.05525	0.726	0.06246	0.819
140	0.867	0.05320	0.696	0.06134	0.804
145	0.860	0.05100	0.667	0.06018	0.789
150	0.853	0.04865	0.638	0.05897	0.773
155	0.846	0.04615	0.605	0.05772	0.756
160	0.839	0.04340	0.569	0.05636	0.739
165	0.832	0.04050	0.531	0.05498	0.721
170	0.826	0.03735	0.489	0.05349	0.701
175	0.819	0.03400	0.446	0.05136	0.681
180	0.813	0.03035	0.397	0.05029	0.659
185	0.807	0.02645	0.347	0.04855	0.637
190	0.800	0.02225	0.292	0.04665	0.612
195	0.794	0.01775	0.221	0.04475	0.588
200	0.788	0.01300	0.173	0.04276	0.561
205	0.782	0.00785	0.103	0.04061	0.532
210	0.776	0.00230	0.030	0.03827	0.502
212	0.774	0.00000	0.000	0.03732	0.489

TABLE IV.—FACTORS FOR GAS OF 0.75 SPECIFIC GRAVITY.

Temperature degrees F.	Volume factor	Partial gas density	Partial gas ratio	Total density	Specific ratio
0	1.130	0.06470	0.847	0.06474	0.848
10	1.106	0.06330	0.829	0.06339	0.831
20	1.083	0.06190	0.810	0.06205	0.813
30	1.061	0.06045	0.791	0.06069	0.795
32	1.057	0.06020	0.789	0.06050	0.793
40	1.040	0.05910	0.775	0.05951	0.780
45	1.030	0.05840	0.766	0.05889	0.772
50	1.019	0.05770	0.756	0.05829	0.764
55	1.009	0.05700	0.747	0.05770	0.756
60	1.000	0.05624	0.737	0.05707	0.748
65	0.991	0.05548	0.727	0.05645	0.740
70	0.982	0.05472	0.717	0.05587	0.732
75	0.972	0.05396	0.706	0.05530	0.724
80	0.963	0.05320	0.696	0.05477	0.717
85	0.954	0.05244	0.687	0.05427	0.711
90	0.946	0.05160	0.675	0.05373	0.703
95	0.937	0.05070	0.664	0.05317	0.696
100	0.929	0.04980	0.652	0.05265	0.689
105	0.921	0.04875	0.638	0.05203	0.681
110	0.913	0.04770	0.625	0.05147	0.674
115	0.905	0.04665	0.610	0.05096	0.667
120	0.897	0.04548	0.596	0.05040	0.660
125	0.889	0.04425	0.579	0.04985	0.652
130	0.882	0.04288	0.560	0.04925	0.644
135	0.874	0.04143	0.543	0.04864	0.636
140	0.867	0.03990	0.520	0.04804	0.628
145	0.860	0.03825	0.498	0.04743	0.620
150	0.853	0.03649	0.477	0.04681	0.612
155	0.846	0.03642	0.453	0.04619	0.604
160	0.839	0.03255	0.426	0.04551	0.596
165	0.832	0.03038	0.399	0.04486	0.589
170	0.826	0.02802	0.367	0.04416	0.579
175	0.819	0.02550	0.334	0.04346	0.569
180	0.813	0.02277	0.297	0.04271	0.559
185	0.807	0.01984	0.259	0.04194	0.549
190	0.800	0.01668	0.218	0.04108	0.538
195	0.794	0.01332	0.160	0.04032	0.527
200	0.788	0.00975	0.129	0.03951	0.517
205	0.782	0.00589	0.077	0.03865	0.506
210	0.776	0.00172	0.022	0.03769	0.494
212	0.774	0.00000	0.000	0.03732	0.489

TABLE V.—FACTORS FOR GAS OF 0.70 SPECIFIC GRAVITY.

Temperature degrees F.	Volume factor	Partial gas density	Partial gas ratio	Total density	Specific ratio
0	1.130	0.06040	0.791	0.06045	0.792
10	1.106	0.05910	0.774	0.05920	0.776
20	1.083	0.05780	0.756	0.05796	0.759
30	1.061	0.05640	0.738	0.05665	0.742
32	1.057	0.05620	0.736	0.05650	0.740
40	1.040	0.05520	0.724	0.05561	0.729
45	1.030	0.05455	0.715	0.05504	0.721
50	1.019	0.05395	0.706	0.05448	0.714
55	1.009	0.05320	0.697	0.05390	0.706
60	1.000	0.05250	0.687	0.05333	0.698
65	0.991	0.05180	0.678	0.05277	0.691
70	0.982	0.05140	0.672	0.05225	0.687
75	0.972	0.05040	0.661	0.05175	0.679
80	0.963	0.04970	0.651	0.05127	0.672
85	0.954	0.04900	0.641	0.05083	0.665
90	0.946	0.04820	0.630	0.05033	0.658
95	0.937	0.04735	0.621	0.04987	0.653
100	0.929	0.04645	0.609	0.04930	0.646
105	0.921	0.04550	0.596	0.04878	0.639
110	0.913	0.04450	0.583	0.04820	0.632
115	0.905	0.04350	0.569	0.04781	0.626
120	0.897	0.04242	0.556	0.04734	0.620
125	0.889	0.04130	0.541	0.04690	0.614
130	0.882	0.04002	0.524	0.04639	0.608
135	0.874	0.03868	0.507	0.04589	0.601
140	0.867	0.03723	0.486	0.04537	0.594
145	0.860	0.03570	0.466	0.04488	0.588
150	0.853	0.03405	0.446	0.04437	0.581
155	0.846	0.03231	0.423	0.04388	0.574
160	0.839	0.03039	0.397	0.04335	0.567
165	0.832	0.02835	0.370	0.04283	0.560
170	0.826	0.02617	0.341	0.04231	0.553
175	0.819	0.02380	0.311	0.04176	0.546
180	0.813	0.02123	0.277	0.04117	0.539
185	0.807	0.01850	0.242	0.04061	0.532
190	0.800	0.01557	0.204	0.03997	0.524
195	0.794	0.01243	0.149	0.03943	0.516
200	0.788	0.00910	0.120	0.03886	0.508
205	0.782	0.00549	0.071	0.03825	0.500
210	0.776	0.00161	0.020	0.03758	0.492
212	0.774	0.00000	0.000	0.03732	0.489

TABLE VI.—Factors for Gas of 0.65 Specific Gravity.

Temperature degrees F.	Volume factor	Partial gas density	Partial gas ratio	Total density	Specific ratio
0	1.130	0.05610	0.735	0.05615	0.736
10	1.106	0.05483	0.717	0.05493	0.719
20	1.083	0.05363	0.702	0.05379	0.705
30	1.061	0.05240	0.686	0.05265	0.690
32	1.057	0.05220	0.684	0.05250	0.688
40	1.040	0.05130	0.672	0.05171	0.677
45	1.030	0.05060	0.663	0.05109	0.669
50	1.019	0.05000	0.655	0.05053	0.663
55	1.009	0.04940	0.647	0.05010	0.656
60	1.000	0.04875	0.639	0.04958	0.650
65	0.991	0.04810	0.631	0.04908	0.644
70	0.982	0.04745	0.623	0.04850	0.638
75	0.972	0.04680	0.614	0.04815	0.632
80	0.963	0.04615	0.604	0.04772	0.625
85	0.954	0.04550	0.596	0.04733	0.620
90	0.946	0.04475	0.586	0.04688	0.614
95	0.937	0.04395	0.576	0.04649	0.608
100	0.929	0.04315	0.565	0.04600	0.602
105	0.921	0.04225	0.555	0.04553	0.598
110	0.913	0.04132	0.541	0.04509	0.590
115	0.905	0.04040	0.528	0.04471	0.585
120	0.897	0.03940	0.516	0.04432	0.580
125	0.889	0.03832	0.502	0.04392	0.575
130	0.882	0.03714	0.486	0.04351	0.570
135	0.874	0.03591	0.471	0.04312	0.564
140	0.867	0.03458	0.451	0.04272	0.559
145	0.860	0.03315	0.332	0.04233	0.554
150	0.853	0.03161	0.414	0.04193	0.549
155	0.846	0.03000	0.393	0.04157	0.544
160	0.839	0.02821	0.369	0.04117	0.539
165	0.832	0.02632	0.344	0.04080	0.534
170	0.826	0.02429	0.317	0.04043	0.529
175	0.819	0.02210	0.289	0.04006	0.524
180	0.813	0.01973	0.257	0.03967	0.519
185	0.807	0.01719	0.224	0.03929	0.514
190	0.800	0.01445	0.183	0.03885	0.509
195	0.794	0.01154	0.157	0.03854	0.504
200	0.788	0.00845	0.111	0.03821	0.499
205	0.782	0.00510	0.065	0.03786	0.494
210	0.776	0.00149	0.017	0.03746	0.489
212	0.774	0.00000	0.000	0.03732	0.489

TABLE VII.—Factors for Gas of 0.60 Specific Gravity.

Temperature degrees F.	Volume factor	Partial gas density	Partial gas ratio	Total density	Specific ratio
0	1.130	0.05178	0.678	0.05183	0.679
10	1.106	0.05032	0.662	0.05075	0.664
20	1.083	0.04953	0.648	0.04967	0.651
30	1.061	0.04835	0.633	0.04860	0.637
32	1.057	0.04815	0.631	0.04845	0.635
40	1.040	0.04731	0.620	0.04772	0.625
45	1.030	0.04672	0.613	0.04721	0.619
50	1.019	0.04618	0.605	0.04677	0.613
55	1.009	0.04560	0.596	0.04630	0.607
60	1.000	0.04500	0.589	0.04583	0.600
65	0.991	0.04440	0.581	0.04538	0.594
70	0.982	0.04380	0.573	0.04495	0.588
75	0.972	0.04320	0.565	0.04455	0.583
80	0.963	0.04260	0.557	0.04417	0.578
85	0.954	0.04200	0.549	0.04383	0.573
90	0.946	0.04130	0.540	0.04343	0.568
95	0.937	0.04055	0.531	0.04302	0.563
100	0.929	0.03980	0.521	0.04265	0.558
105	0.921	0.03900	0.510	0.04228	0.553
110	0.913	0.03817	0.500	0.04194	0.549
115	0.905	0.03735	0.488	0.04162	0.545
120	0.897	0.03638	0.477	0.04130	0.541
125	0.889	0.03540	0.464	0.04100	0.537
130	0.882	0.03429	0.448	0.04066	0.532
135	0.874	0.03315	0.435	0.04036	0.528
140	0.867	0.03191	0.416	0.04005	0.524
145	0.860	0.03060	0.398	0.03978	0.520
150	0.853	0.02919	0.382	0.03951	0.517
155	0.846	0.02770	0.363	0.03927	0.514
160	0.839	0.02605	0.341	0.03901	0.511
165	0.832	0.02430	0.318	0.03878	0.508
170	0.826	0.02242	0.293	0.03856	0.505
175	0.819	0.02040	0.267	0.03836	0.502
180	0.813	0.01821	0.237	0.03815	0.499
185	0.807	0.01586	0.206	0.03796	0.496
190	0.800	0.01334	0.174	0.03774	0.494
195	0.794	0.01065	0.125	0.03765	0.492
200	0.788	0.00780	0.103	0.03756	0.491
205	0.782	0.00471	0.061	0.03747	0.490
210	0.776	0.00138	0.007	0.03735	0.489
212	0.774	0.00000	0.000	0.03732	0.489

TABLE VIII.—FACTORS FOR GAS OF 0.55 SPECIFIC GRAVITY.

Temperature degrees F.	Volume factor	Partial gas density	Partial gas ratio	Total density	Specific ratio
0	1.130	0.04745	0.621	0.04750	0.622
10	1.106	0.04640	0.607	0.04650	0 609
20	1.083	0.04539	0.594	0.04555	0.597
30	1.061	0.04435	0.584	0.04460	0.584
32	1.057	0.04415	0.578	0.04445	0.582
40	1.040	0.04335	0.568	0.04376	0.573
45	1.030	0.04282	0.561	0.04331	0.567
50	1.019	0.04231	0.554	0.04290	0.562
55	1.009	0.04179	0.548	0.04249	0.557
60	1.000	0.04126	0.541	0.04208	0.552
65	0.991	0.04070	0.533	0.04168	0.546
70	0.982	0.04015	0.526	0.04139	0.541
75	0.972	0.03960	0.518	0.04095	0.536
80	0.963	0.03905	0.511	0.04062	0.532
85	0.954	0.03850	0.504	0.04033	0.528
90	0.946	0.03790	0.496	0.04003	0.524
95	0.937	0.03720	0.488	0.03967	0.520
100	0.929	0.03650	0.479	0.03935	0.516
105	0.921	0.03575	0.469	0.03903	0.512
110	0.913	0.03497	0.459	0.03874	0.508
115	0.905	0.03420	0.447	0.03851	0.504
120	0.897	0.03335	0.437	0.03827	0.501
125	0.889	0.03243	0.425	0.03803	0.498
130	0.882	0.03142	0.411	0.03779	0.495
135	0.874	0.03040	0.399	0.03761	0.492
140	0.867	0.02927	0.382	0.03741	0.490
145	0.860	0.02805	0.366	0.03723	0.488
150	0.853	0.02677	0.351	0.03709	0.486
155	0.846	0.02538	0.333	0.03695	0.484
160	0.839	0.02388	0.312	0.03684	0.482
165	0.832	0.02227	0.291	0.03675	0.481
170	0.826	0.02054	0.268	0.03668	0.480
175	0.819	0.01870	0.245	0.03666	0.480
180	0.813	0.01669	0.218	0.03663	0.480
185	0.807	0.01455	0.190	0.03665	0.480
190	0.800	0.01224	0.160	0.03664	0.480
195	0.794	0.00976	0.114	0.03576	0.481
200	0.788	0.00715	0.095	0.03631	0.483
205	0.782	0.00432	0.057	0.03708	0.486
210	0.776	0.00126	0.016	0.03723	0.488
212	0.774	0.00000	0.000	0.03732	0.489

TABLE IX.—FACTORS FOR GAS OF 0.50 SPECIFIC GRAVITY.

Temperature degrees F.	Volume factor	Partial gas density	Partial gas ratio	Total density	Specific ratio
0	1.130	0.04315	0.565	0.04320	0.566
10	1.106	0.04220	0.552	0.04230	0.554
20	1.083	0.04125	0.540	0.04142	0.543
30	1.061	0.04030	0.527	0.04055	0.531
32	1.057	0.04013	0.525	0.04043	0.529
40	1.040	0.03940	0.517	0.03982	0.522
45	1.030	0.03893	0.510	0.03942	0.516
50	1.019	0.03848	0.504	0.03907	0.512
55	1.009	0.03800	0.498	0.03870	0.507
60	1.000	0.03730	0.491	0.03833	0.502
65	0.991	0.03700	0.485	0.03798	0.498
70	0.982	0.03650	0.478	0.03765	0.493
75	0.972	0.03600	0.471	0.03735	0.489
80	0.963	0.03550	0.465	0.03707	0.486
85	0.954	0.03500	0.458	0.03683	0.482
90	0.946	0.03442	0.451	0.03655	0.479
95	0.937	0.03380	0.444	0.03627	0.476
100	0.929	0.03317	0.435	0.03603	0.472
105	0.921	0.03250	0.426	0.03578	0.469
110	0.913	0.03180	0.417	0.03557	0.466
115	0.905	0.03110	0.406	0.03541	0.463
120	0.897	0.03032	0.397	0.03525	0.461
125	0.889	0.02950	0.386	0.03510	0.459
130	0.882	0.02858	0.374	0.03495	0.458
135	0.874	0.02763	0.363	0.03484	0.456
140	0.867	0.02660	0.347	0.03474	0.455
145	0.860	0.02550	0.332	0.03468	0.454
150	0.853	0.02433	0.319	0.03465	0.454
155	0.846	0.02308	0.303	0.03465	0.454
160	0.839	0.02170	0.284	0.03466	0.454
165	0.832	0.02025	0.265	0.03473	0.455
170	0.826	0.01868	0.244	0.03482	0.456
175	0.819	0.01700	0.223	0.03496	0.458
180	0.813	0.01518	0.197	0.03512	0.459
185	0.807	0.01323	0.172	0.03533	0.462
190	0.800	0.01113	0.145	0.03553	0.465
195	0.794	0.00888	0.102	0.03588	0.469
200	0.788	0.00650	0.087	0.03626	0.475
205	0.782	0.00393	0.052	0.03669	0.481
210	0.776	0.00115	0.014	0.03712	0.486
212	0.774	0.00000	0.000	0.03732	0.489

TABLE X.—FACTORS FOR GAS OF 0.45 SPECIFIC GRAVITY.

Temperature degrees F.	Volume factor	Partial gas density	Partial gas ratio	Total density	Specific ratio
0	1.130	0.03882	0.499	0.03888	0.510
10	1.106	0.03798	0.497	0.03809	0.499
20	1.083	0.03713	0.486	0.03730	0.489
30	1.061	0.03630	0.475	0.03656	0.479
32	1.057	0.03612	0.473	0.03642	0.477
40	1.040	0.03548	0.465	0.03589	0.470
45	1.030	0.03503	0.459	0.03552	0.465
50	1.019	0.03462	0.453	0.03520	0.461
55	1.009	0.03420	0.448	0.03490	0.457
60	1.000	0.03376	0.442	0.03459	0.453
65	0.991	0.03330	0.436	0.03428	0.449
70	0.982	0.03284	0.430	0.03398	0.445
75	0.972	0.03238	0.423	0.03372	0.441
80	0.963	0.03192	0.417	0.03349	0.438
85	0.954	0.03146	0.412	0.03329	0.436
90	0.946	0.03096	0.405	0.03309	0.433
95	0.937	0.03042	0.399	0.03288	0.431
100	0.929	0.02989	0.391	0.03273	0.428
105	0.921	0.02926	0.383	0.03254	0.426
110	0.913	0.02862	0.375	0.03239	0.424
115	0.905	0.02798	0.366	0.03229	0.423
120	0.897	0.02728	0.358	0.03220	0.422
125	0.889	0.02055	0.348	0.03215	0.421
130	0.882	0.02572	0.356	0.03209	0.420
135	0.874	0.02487	0.327	0.03208	0.420
140	0.867	0.02393	0.412	0.03207	0.420
145	0.860	0.02295	0.299	0.03213	0.421
150	0.853	0.02189	0.287	0.03221	0.422
155	0.846	0.02077	0.272	0.03234	0.423
160	0.839	0.01958	0.256	0.03254	0.426
165	0.832	0.01822	0.338	0.03270	0.428
170	0.826	0.01680	0.219	0.03294	0.431
175	0.819	0.01530	0.201	0.03326	0.436
180	0.813	0.01366	0.178	0.03360	0.440
185	0.807	0.01180	0.154	0.03390	0.444
190	0.800	0.01001	0.130	0.03441	0.450
195	0.794	0.00799	0.091	0.03499	0.458
200	0.788	0.00585	0.078	0.03561	0.466
205	0.782	0.00353	0.046	0.03629	0.475
210	0.776	0.00135	0.017	0.03732	0.489
212	0.774	0.00000	0.000	0.03732	0.489

TABLE XI.—FACTORS FOR GAS OF 0.40 SPECIFIC GRAVITY.

Temperature degrees F	Volume factor	Partial gas density	Partial gas ratio	Total density	Specific ratio
0	1.130	0.03450	0.452	0.03456	0.453
10	1.106	0.03375	0.442	0.03386	0.444
20	1.083	0.03300	0.432	0.03317	0.435
30	1.061	0.03225	0.424	0.03251	0.426
32	1.057	0.03211	0.420	0.03241	0.424
40	1.040	0.03152	0.413	0.03193	0.418
45	1.030	0.03113	0.408	0.03162	0.414
50	1.019	0.03078	0.403	0.03137	0.411
55	1.009	0.03040	0.398	0.03110	0.407
60	1.000	0.03000	0.393	0.03083	0.404
65	0.991	0.02960	0.388	0.03058	0.401
70	0.982	0.02920	0.383	0.03035	0.398
75	0.972	0.02880	0.377	0.03015	0.395
80	0.963	0.02840	0.372	0.02997	0.393
85	0.954	0.02800	0.367	0.02983	0.391
90	0.946	0.02755	0.361	0.02968	0.389
95	0.937	0.02705	0.355	0.02952	0.387
100	0.929	0.02655	0.348	0.02940	0.385
105	0.921	0.02600	0.340	0.02928	0.383
110	0.913	0.02542	0.333	0.02919	0.382
115	0.905	0.02485	0.325	0.02916	0.382
120	0.897	0.02425	0.318	0.02917	0.382
125	0.889	0.02360	0.309	0.02920	0.382
130	0.882	0.02287	0.299	0.02924	0.383
135	0.874	0.02210	0.291	0.02931	0.384
140	0.867	0.02128	0.277	0.02942	0.385
145	0.860	0.02040	0.265	0.02958	0.387
150	0.853	0.01946	0.255	0.02978	0.390
155	0.846	0.01846	0.242	0.03303	0.393
160	0.839	0.01736	0.227	0.03032	0.397
165	0.832	0.01620	0.212	0.03068	0.402
170	0.826	0.01494	0.195	0.03108	0.407
175	0.819	0.01360	0.178	0.03156	0.413
180	0.813	0.01214	0.158	0.03208	0.420
185	0.807	0.01058	0.138	0.03268	0.428
190	0.800	0.00890	0.116	0.03330	0.436
195	0.794	0.00710	0.079	0.03410	0.446
200	0.788	0.00520	0.076	0.03496	0.458
205	0.782	0.00314	0.041	0.03590	0.470
210	0.776	0.00092	0.011	0.03689	0.483
212	0.774	0.00000	0.000	0.03732	0.489

THE CHAIRMAN: You have heard Mr. Spitzglass' very interesting paper. It is now open for discussion.

MR. J. W. BATTEN (Detroit, Mich.): Mr. Chairman, this paper appeals to me as being a very interesting one, and one that represents a very valuable contribution to the literature on the use of the Pitot tube, and particularly its application in the gas business. I believe we are indebted to Mr. Spitzglass for very large contributions to the particular use of the Pitot tube in connection with our business. He made many valuable suggestions in his report last year, and this is an addition to the literature on the subject that seems to me is going to be valuable in practice.

During the past two years a large number of instruments have been added to the equipment of the modern water gas plant in the way of measuring devices for air and steam, and pyrometers. This is an additional instrument which will undoubtedly be of value. To those of us who are operating machines, where retort house coke containing variable proportions of moisture and of varying quality as to proportion of breeze and fine coke is used this instrument, I believe, will be of considerable value because the quality of gas which we ultimately obtain is very largely, if not almost entirely, dependent on the condition of the generator. This condition varies very rapidly and easily with a fuel which is not uniform. Those who may be operating with anthracite coal or with coke which has been carefully screened and prepared probably do not meet with the difficulties which are met with in operations where a fuel is used which lacks this uniformity, and I am convinced that a device which will measure the volume or the relative output from the machine, where the generator conditions vary so materially in a short period of time, will be found very valuable.

MR. W. H. FULWEILER (Philadelphia): I feel that the Manufacturing Section is greatly indebted to Mr. Spitzglass for the very painstaking manner in which he has worked on the Pitot tube and the particular form of it for this purpose. I feel sure that the additional work with this apparatus will lead to information that will undoubtedly assist in the operation of water gas sets.

Mr. Spitzglass has described two forms of Pitot tube, the equal area tube and the 70° tube. I think we would like to hear what his final judgment is as to their relative accuracy. There are several points regarding the 70° tube to which attention should be called. This form of tube appears to be rather sensitive to slight variations in its position relative to the axis of flow. It is also apparently quite easily thrown out by the presence of small particles of dirt or carbon forming on the face of the angle of the tube.

In connection with the general use of Pitot tubes, the shape of the velocity curve is likely to vary considerably with the velocity unless the point of observation is at a considerable distance from any disturbing factor such as a bend or outlet, so that the point of maximum flow is not fixed but varies in its position with the velocity.

In one point I must take issue with Mr. Spitzglass and that is as to his assumption that the gas leaving the wash-box is saturated with water vapor. We have made some experiments looking to the determination of this point and my recollection is that the gas is only about two-thirds saturated. The gas apparently passes through the wash-box so rapidly that it pushes the water away so that only a small percentage of the gas passing through the wash-box comes in contact with the water. In fact some experiments indicate that gas is not always completely saturated after passing through an ordinary wet test meter.

I would like to ask Mr. Spitzglass whether he can tell us from his experience about how long you would have to continue the observations on a generator to draw any accurate conclusions as to the relative steam supply. I notice in the table in which he quotes observations over a number of runs that there is a considerable variation from run to run, and I would like to know about how long he feels that you must observe any particular generator to draw an accurate conclusion as to whether or not any radical change is necessary in the steam supply.

THE CHAIRMAN: Does anybody else wish to discuss this paper?

MR. O. B. EVANS (Philadelphia): Mr. Spitzglass has, as usual, prepared a very carefully thought out and excellent paper, and the tables he has presented will undoubtedly prove of considerable value to us all. He draws attention to the fact that there is a great advantage in knowing the output from individual machines, and I believe that we all agree with him because it is generally recognized that a plant operating a single machine will almost invariably give better results than one in which two or three sets are operating at the same time. This, of course, is undoubtedly due to the fact that when the results fall off in a multiple unit plant it is difficult to determine which of the sets is doing the damage.

One of the most valuable features of this paper seems, however, to be in pointing out the difficulties to be met with in endeavoring to measure the output from individual water gas sets by a device of this type. It depends for its registration upon the specific gravity of the gas measured. We know very well that the specific gravity of the gas must vary considerably from the beginning to the end of a run, and to determine the average specific gravity during a run is not a simple matter. Moreover, the gas probably leaves the wash-box supersaturated with moisture, since it is entirely feasible to remove from this gas mechanically about 2 or 3 pounds of material per thousand. A variation of 1 per cent. of CO_2 content will represent a difference in weight of somewhat over ½ pound per 1,000 cubic feet.

In the results quoted from the Brooklyn Union Gas Company, page 98, it will be noted that on March 1 the Pitot tube indicated a make per run approximately 10 per cent. less than that determined by the station meter, whereas on March 2, under apparently the same operating conditions, the Pitot tube meter read 10 per cent. fast; that is, there was a maximum variation in the indications of the Pitot tube meter of approximately 20 per cent. With such a wide variation in operations I think we should hesitate to rely absolutely upon the indications of this instrument until it is developed on a more accurate basis. Until then we will probably have to content ourselves with operating by a determination of the CO_2 in the finished gas, and the quantity of steam used.

MR. A. H. SCHAAF (Brooklyn, N. Y.): Considering the fact that the measurement of hot gases by the use of the Pitot tube is in the experimental stage, it has been a source of some very interesting data, and when the present obstacles have been removed it will no doubt prove itself useful in plant operation.

We have made some tests along this line with an equal area tube (the results of which appear in Mr. Spitzglass' paper), and the average of these tests gives a very favorable impression, but the individual readings vary considerably. These variations can possibly be attributed to the following causes:

First: There is a continual downpour of condensation in the "take-off" which no doubt falls on the dynamic tube and causes an oscillating gauge. This can possibly be overcome to a certain extent by the use of a single opening tube such as Mr. Spitzglass has adopted.

Second: Changes in specific volume, as the temperature varies from 200° to 185° F. during each run, and its rate of change is not uniform.

Third: The change of static pressure, which oscillates continually, and especially so when other machines "go on" or "come off" the run.

We have brought up these points, in view of the fact that Mr. Spitzglass has encountered these same difficulties and can inform us how to overcome them.

THE CHAIRMAN: Has any one else anything to say on this paper? If there is no further discussion we will have Mr. Spitzglass close the discussion.

MR. SPITZGLASS: I will try to answer Mr. Fulweiler's questions first. Regarding the saturation of the gas I believe the amount of heat that is in the gas is sufficient to evaporate the water. The gas comes down to a temperature of, say, 180°.

From Table I, the density of water vapor in pounds per cubic foot is at 180°, 0.019940, that is practically 0.02 of a pound, requiring 0.02 of a thousand units, or 20 heat units for complete saturation. Now that gas comes out at 1,200° or 1,300°, and we know it drops down to say 180°, and all that heat is used up in the boiling of that water. I will not say that it is 100 per cent. saturated, I have not figured that out; but being mixed up in the wash-box and then coming out from there and having the moisture present the gas must be saturated if there is enough heat to evaporate the water.

Mr. Fulweiler made the remark that the gas is not even saturated at the station meter. It may be a per cent. or two off, the gas is not different in saturation going into and out of the meter. In some cases it probably drops a little moisture. The whole operation is performed in the wash-box. After this the gas cools down and keeps on dropping water on its way to the meter, and it must be saturated, otherwise it would not drop that water.

Regarding the Pitot tubes we find that for ordinary work the equal area tube is better, but for this work with saturated gases I believe the tube marked No. 9 is better because it is better adapted for cleaning the water. It may not be as accurate as the other one, but this is the one that can do the work in this case.

Regarding the direction of the flow the same is true for every case where the Pitot tube is used. It may be that the device is not very accurate. It is just as accurate as any flow meter. I am working most of the time on those instruments, and I will say they are just as accurate as we can make them. At the same time there are tens of thousands of those meters installed; they are not absolutely accurate, and I do not think there is anything in this world absolutely accurate.

Take the station meter. We test it only on a very slow flow, and we know that at higher discharges the meter changes the water level, it changes the operation. But we have no means of testing it. If we desire to test it with a large holder then we will be still worse off, because the holder will be sensitive to changes of temperature and many other factors that we could not control.

A gentleman whom we all know told me yesterday evening that he was called on a consulting work where it was necessary to determine the accuracy of an orifice meter that was operated at the place. He said that the inlet to the orifice was full of water, it would drain over the orifice all the time, and the specific gravity was changing, or it could change without any notice 100 per cent., and the temperature was changing from 60 to over 100, and so on. But at the same time that meter was used to measure the gas and it was still better than not to measure it at all.

I do not claim that this instrument should be used for measuring the actual quantity of the gas. But for observing the operation of the machine with this instrument, it does not matter whether it is actually accurate or not, it shows instantaneously the change that is going on in the operation and that is sufficient, and I think that as we work on it more we will still improve it. We have not perfected it yet.

Mr. Fulweiler asks how long we have to observe it to see the difference? Just one second. We see the change at once. The instrument is not for actually measuring the gas, it is merely for indicating the operation the same as a pressure gauge indicates, and I believe it will at least show as much as any single one of the instruments that we have on the machine.

The question of maximum velocity is another variable affecting the accuracy of the Pitot tube in general. I had occasion to verify a certain thing lately. When we have a long stretch of pipe we usually obtain the maximum velocity in the center of the pipe. I have tried either the equal area tube or this one, and if the maximum velocity is in the center this tube will have a coefficient of about 80 almost invariably. If the pipe is very short, and it is right at an elbow, and the maximum velocity comes off the center, then in every case the tube has to be calibrated for the purpose, because if the maximum velocity comes nearer to the wall it occupies a smaller area, and the same maximum velocity will not give the same amount of flow as when it comes near the center of the pipe. I think I took up all the points Mr. Fulweiler mentioned. If not, will you kindly remind me.

MR. FULWEILER: Mr. Spitzglass apparently has misunderstood my question. It was purely a practical one. We know that nearly every run varies from the one preceding and the one succeeding it. I wish to know how many runs should be taken into consideration before deciding that the steam supply is not in proper adjustment and that a change should be made.

MR. SPITZGLASS: I believe that the information as far as the amount of steam is concerned can be obtained from a single run. The idea is this. We have a certain amount of heat stored up in the machine. Each cycle of blast and run first increases and then reduces the heat to the original amount, as far as this can be done. Now if we supply an excessive amount of steam the heat is removed much sooner and the instrument begins to show that the flow is reduced, though we keep on supplying the same steam and the same oil. You will find that a chemical analysis of the gas during the various parts of the run will indicate that when the flow is reduced with the same supply of oil and steam the gas is of a much lower quality, because there is not enough heat in the machine to properly decompose the steam. See, for instance, curve No. 1. We increased the flow of steam, and we made more gas at the beginning of the run. But at the end of the run the make dropped off considerably, showing that the supply of steam was too high for the desired length of the run.

Of course, as far as we have gone with this work I was mainly the instrument maker. I did not have time enough to be the gas maker with it. That comes next. I just want to bring your attention to the fact that the device is so easily applied. As you know, there are many flow meters on the market. They have instruments worked out to record the indications which the differential pressure gives us. Then if we fix up this thing so that they can get the differential pressure, they will surely develop the instruments to record it, so we can work more efficiently. Does that answer your question, Mr. Fulweiler.

MR. FULWEILER: Yes, thank you.

THE CHAIRMAN: We are very much indebted to Mr. Spitzglass for his very interesting and instructive paper, and I want to thank him.

Now, I find it is our duty under the Constitution to select three members of this section, one of whom the Committee on Nominations reporting to the 1917 meeting must choose as a candidate for Vice-President to represent the Manufacturing Section. In order to do this we will have to select a nominating committee, and I will ask Mr. James A. Brown, of Jackson, Michigan, Mr. Alva F. Traver, of Denver, and Mr. J. P. Kennedy, of Cambridge, to compose that committee and to report after the second paper this afternoon.

It is now 5 minutes to 1, and I think probably we had better adjourn to 2.30 this afternoon.

Thereupon the meeting was adjourned, to reconvene at 2.30 P. M., Tuesday, October 17, 1916.

MANUFACTURING SECTION.

Second Session, Tuesday, October 17, 1916, 2 P. M.

H. C. ABELL, *Vice-President,* presiding.
J. S. JACKSON, *Secretary.*

THE CHAIRMAN: The first paper this afternoon is the report of the Committee on Classification of Gas Engineering.

REPORT OF THE COMMITTEE ON CLASSIFICATION OF GAS ENGINEERING.

MR. H. W. PECK (Schenectady, N. Y.): This subject was first brought to the attention of the Accounting Division two years ago, and it may not be familiar to many of the members of the Manufacturing Section.

This report is really a report of the Joint Committee on Classification of Technical Literature comprising thirty-two national associations rather than of the Institute Committee itself.

As I reported last year, your committee extended invitations to other technical societies to join in this work. After several preliminary meetings which disclosed great interest in the proposed undertaking, an executive committee was elected comprising Mr. F. R. Lowe of the American Society of Mechanical Engineers, Chairman; Dr. W. P. Cutter, American Institute of Mining Engineers and Librarian of the Engineering Society, Secretary; Dr. Samuel Sheldon, Chairman of the Library Committee, United Engineering Society; Professor Edgar Marburg, American Society for Testing Materials; Mr. Henry W. Peck, American Gas Institute.

To this executive committee was assigned the duty of studying the scope of the work and ways and means of carrying it along. They held many meetings in New York, all of which I attended. The scope to be covered by the Joint Committee is shown on the attached chart, which also shows the partial development of the main subject, Applied Science, and of the subdivisions, Engineering, Dynamics, Steam Development and Draft.

A largely attended general meeting of the Joint Committee was held on April 1, which was well reported in the technical press. This meeting approved of the work accomplished by the executive committee and of their recommendations that different subjects be assigned to the member societies for their detailed development. This point aroused spirited discussion, several members feeling that a trained classifier should be employed to develop the classifications with the advice of subcommittees for different subjects. The outcome of the discussion was that the executive committee was instructed to acquaint itself with the attitude of the different organizations toward assisting the Joint Committee in organizing classifications of literature of vital interest to them. Favorable reports have been received from enough of these societies to indicate that the detailed classification will be carried on actively along many lines. I have agreed, on behalf of the American Gas Institute, to develop the subject of gas as shown on the chart.

It will be of great assistance if any members of the Institute who have studied the art of classification and are willing to devote some time to this, will so advise the Secretary of the Institute.

It will be of interest to quote parts of a paper entitled "How to Make a Classification" read by Dr. Cutter before the last meeting of the committee.

> The classification is to be made for technical literature, in other words, our attempt should be to make such a classification as would group together published literature on a subject, and not to provide separate divisions for each test, description or fact. Where there is little or no literature on a subject, the classification should be broad; where the literature is voluminous, the classification should be correspondingly detailed.
>
> Example: The literature on alloy steels is voluminous; a classification of this should be extremely detailed, for the increase in literature on this specific subject is very great. So of submarines, aeroplanes, automobiles and the like.

But, at the present, published material on the flow of fluids in pipes and through orifices is, in comparison, slight. There are, of course, many applications which will occur to all of us; but the published literature is not voluminous.

So, for alloy steels, we should make an extensive classification; for the flow of fluids through pipes, a somewhat limited division would be adequate.

The literature should be the guide rather than the objects, processes, facts or tests of which the literature treats.

As a corollary to this statement it is desirable to recognize the fact that a classification of technical literature must of necessity be prepared either by persons who are very familiar with the scope, extent, and relative importance of books and articles treating of the subject classified, or by persons who, although not familiar with that literature, have the requisite intelligence and judgment, as well as the time and opportunity to familiarize themselves with the literature, as a preliminary to its classification. Nor is this all that is necessary; for lack of access to a large collection of this literature makes familiarity with it an impossibility.

The ideal conditions affecting the success of any collaborator in the preparation of a classification, therefore, may be stated briefly as follows:

(1) The opportunity of using a good technical library or one especially strong in the literature of the subject to be covered.

(2) Familiarity with this literature, either already acquired, or to be acquired by study.

(3) Familiarity with other attempts to classify the particular subject to be treated, if such attempts have been made.

(4) Time and inclination to insure reasonable study of the literature and the former attempts at its classification.

(5) Capacity for logical arrangement of closely related divisions, so that any subject may be so treated in classification as to at once appeal to the prospective user.

- GENERALIA
  - Theory
  - Patents and Trade Marks
  - Contracts and Specifications
  - Law
  - Societies and Education
  - Authorities
  - Bibliography
  - Trade Information
  - History and Statistics
  - Miscellaneous
- PHILOSOPHY *
- RELIGION *
- SOCIOLOGY
  - Generalia
  - Political Science
  - Law
  - Political Administration
  - Education
  - Political Economy
  - Commerce—Communication
  - Business
  - Associations
  - Customs
- HISTORY *
- LANGUAGE *
- LITERATURE *
- NATURAL SCIENCE
  - Generalia
  - Mathematics
  - Astronomy
  - Physics
  - Chemistry
  - Geology
  - Paleontology*
  - Biology*
  - Botany*
  - Zoology*
- APPLIED SCIENCE
  - Generalia
  - Medicine*
  - Mining
  - Agriculture
  - Fishing and Hunting
  - Manufacturing
  - ENGINEERING
    - Generalia
    - Surveying
    - Materials
    - Excavation (see mining)
    - Structures
    - Hydraulics
    - Sanitation
    - TRANSPORTAT'N
      - Generalia
      - Roads, Streets and Pavements
      - Road Vehicles
      - Railroads
      - Rolling Stock
      - Hoisting and Conveying
      - Waterways
      - Vessels and Navigation
      - Aerial
    - DYNAMICS
      - Generalia
      - Animal
      - Water
      - Pneumatics
      - STEAM
        - Generalia
        - DEVELOPMENT
          - Plant in Gen'l
          - DRAFT
            - Chimneys
            - Fans and Blowers
            - Jet Apparatus
            - Dampers
            - Auto. Control System
            - Gauges
          - Furnaces and Accessories
          - Boiler
          - Coal and Ash Handling App.
          - Feed Water Apparatus
          - Tests
          - Operation
        - Measurement
        - Transmission
        - Storage
        - Control
        - Applications
      - Gas
      - Electricity
  - Military Arts
  - Naval Arts
- FINE ARTS *

* Not to be developed

After last year's report was prepared but before the annual meeting of the Institute, the member of our committee who was responsible for its organization through his hard work in preparation of a classification system which was presented at the annual meeting in 1914, met with an accident which caused his death. Those who knew Mr. D. S. Knauss will long feel the loss which they have experienced, and the Institute has lost a valuable member. As suggested by Mr. Walton Forstall last year, the successful completion of the classification work will indeed be a splendid memorial to Mr. Knauss.

I recommend that a committee on this subject be continued. As to the personnel, I would merely mention the fact that the chairman of your present committee was elected chairman of the Joint Committee at the last meeting.

THE CHAIRMAN: Gentlemen, you have heard the report of the Committee on Classification of Gas Engineering, and I think we all appreciate the amount of work that has been done by the Committee. We will call on Mr. Forstall to discuss the paper.

MR. A. E. FORSTALL: Mr. Chairman, I do not think there is really much about the paper that we can discuss. All that I can do would be to emphasize the value of a classification, and the almost utter impossibility of our making individual classifications for ourselves. I think I have about as large an index as any one in the room, but my classification is very weak. I find very often when I go to look up a reference, that I do not think of it the same from behind as I did from in front. I place it under one classification, and when I go to look for it I search for it under another classification.

Now, if we can get a committee, the members of which are skilled in classification, to give us a classification that will look the same from both sides, it will be of benefit to us and enable us to keep our indexes in such shape that we can find what we are looking for. I move that we recommend to the Institute that the Committee on Classification of Gas Engineering be continued, and that the present Chairman be continued as Chairman of that Committee.

(Motion seconded.)

THE CHAIRMAN: Is there any discussion on the motion? If not, all in favor say aye; opposed, no. It is carried.

The next paper on the program is the report of the Committee on Misleading Statements, Mr. A. E. Forstall, Chairman.

REPORT OF COMMITTEE ON MISLEADING STATEMENTS.

MR. DANA D. BARNUM, *Chairman,*
Technical Committee,
American Gas Institute.

DEAR SIR:

Your Sub-committee on Misleading Statements begs to submit the following report as to the work done during the year.

At the time the Sub-committee was formed, there had already been taken up by the Technical Committee, the matter of misleading statements made in Technical Paper No. 97 of the Bureau of Mines as to the use of coke for domestic purposes. The matter had been referred to Mr. J. W. Shaeffer for investigation and report. After the formation of the Subcommittee correspondence with Mr. Shaeffer brought out the fact that he, in connection with other producers of coke, had been working with the Bureau of Mines and had secured from the latter the promise to correct the statements in the next edition of Technical Paper No. 97. Since there is often great delay in issuing corrected editions of these papers, the Sub-committee recommended to the Technical Committee that the directors of the Institute be requested to communicate with the Bureau of Mines and ask that this second edition be issued as soon as possible.

There were also referred to the Sub-committee at the time of its formation, some statements made by Miss Lillian Erskine, in which the use of gas was mentioned as an avoidable hazard in the hatting industry. The Sub-committee corresponded with Miss Erskine and obtained a clear statement of her position, after which a memorandum was prepared and published in the American Gas Institute *News*, Vol. V., p. 91. The attention of the Public Service Gas Company was also called to the matter, since Miss Erskine's statement referred to the hat factories in their territory. The officials of this company took up the matter with the State Department of Labor and endeavored to impress upon the latter the error of their views.

Another matter referred to the Sub-committee was statements made in a book called "Household Discoveries and Mrs. Curtis's Cook Book" in regard to searching for small leaks of gas with a lighted match. A letter was prepared and sent to Success Company, the publishers of this book, calling attention to the danger of searching for gas leaks with a flame, and this letter was also published in the Gas Institute *News*, Vol. V., p. 94.

The attention of the Sub-committee having been called to an article in a periodical named *Current Comment* on the danger from carbon monoxide poisoning, which was stated to have increased with the use of carbureted water gas, and it being impossible to discover the publishers of this periodical, a memorandum was prepared showing that the vital statistics of various cities in which the gas supplied had been changed from coal gas to carbureted water gas, or from carbureted water gas to coal gas, did not indicate that there was any material difference in the number of deaths from gas poisoning per 100,000 of the population when one kind of gas was substituted for the other. This memorandum was published in the Gas Institute *News*, Vol. V., p. 92.

An article in *Current Opinion* entitled, "Putting Cheap Gas on the Map," was called to the attention of your Sub-committee and, since it seemed harmful because of giving the impression that it was possible to sell gas for house-heating purposes at prices varying from $0.30 to $0.50 per 1,000 cubic feet of gas, a memorandum on the subject of the effect of the poor load factor of the house-heating business upon the possibility of selling gas for this purpose at low prices, was prepared and published in the Gas Institute *News,* Vol V., p. 186.

Certain statements of Mr. A. B. Turner on the percentage of gas used for lighting purposes and the extent to which there was successful competition with gas by electricity for heating and cooking, were also considered by your Sub-committee. Data as to the probable percentage of gas sold for lighting purposes, and the extent to which the competition of electricity for heating and cooking had been felt, was secured from various Massachusetts gas companies named in Mr. Turner's circular letter. From this data a letter was prepared and sent to Mr. Turner informing him that the facts obtainable showed a large percentage of gas sold for lighting purposes and the practical non-existence of electric heating and cooking in the districts named by him.

In the April issue of *Engineering Magazine* there was published an article on artificial lighting, in which it was assumed that any well-designed lighting of factories must necessarily be electric. While this matter was nominally referred to your Sub-committee, it was practically handled by the office of the President of the Institute and arrangements were made to have prepared a paper on the subject, which would be sent to *Engineering Magazine* for publication. Such a paper was prepared by Mr. Thomas Scofield under the title of "Gas Lighting in Industrial Plants," and this paper has been accepted for publication by the *Engineering Magazine.*

An article in the *Electrical World* for July, 1916, was called to the attention of your Sub-committee because of some erroneous statements made in it as to the efficiency of gas water heaters. A memorandum calling attention to these errors was sent through the Sub-committee to the Editor of *Electrical World,* with a request that the errors be corrected. Up to date no such correction has been noted, but if one does not soon appear the magazine will be again communicated with.

Attention was also called to a humorcus article on gas meters in the *Nation*, but it did not seem that it was necessary to take this up seriously.

Respectfully submitted,

ALFRED E. FORSTALL, *Chairman.*

THE CHAIRMAN: Gentlemen, we have heard the very important report of the Committee on Misleading Statements. The report is now open for discussion. We have a written discussion from Mr. Fogg, of New York, which I will ask the Secretary to read.

MR. O. H. FOGG (New York): (Written discussion communicated.) This report is a very modest statement of some extremely important and valuable work which the Committee has performed. From personal experience in these matters, I know that their task has not been an easy one—and while their results are summed up in three pages, the actual benefit to the gas industry of this activity has been far reaching, and of much greater importance than this modest report would indicate.

The National Commercial Gas Association has a similar committee, and it seems to me that co-operation between it and the Institute's Committee will lead to even better results; and I believe, too, that the various State and District Associations throughout the country should be asked to co-operate, or to take action along similar lines, so that there may be an added weight of protest to misleading statements, injudicious or harmful publicity and similar activities in which misrepresentation, if allowed to go unchecked, exerts a harmful influence upon our business.

The report refers to Mr. Scofield's paper on "Gas Lighting in Industrial Plants," prepared in reply to Mr. Becker's paper on "Artificial Lighting," which appeared in the April issue of the *Engineering Magazine.* Mr. Scofield's paper appears in the current issue of the *Engineering Magazine,* with the following preface by the Editors:

"In his chapter on 'Artificial Lighting' in our April issue, Mr. O. M. Becker, expressed the opinion that in the modern industrial establishments the electric light was practically the only illuminating agency to be considered. His statements met with a storm of protest from representatives of gas associations and from others. At the suggestion of the President of the American Gas Institute, Mr. Scofield prepared the following paper, which not only sets forth the advantages of gas as a lighting agent in manufacturing plants, but is also a valuable contribution to the general study of factory illumination."

THE CHAIRMAN: I do not know whether Mr. Fogg intended the suggestion to continue the Committee and to work in connection with the National Commercial Gas Association, to be a motion or not. I tried to get him on the telephone, but I was unable to communicate with him before I left New York.

MR. A. M. BARNES: Mr. Forstall omitted to say what was meted out to the Boston broker.

MR. A. E. FORSTALL: The Chairman of the Committee obtained from the Massachusetts companies specially mentioned in this circular letter statistics as to the amount of gas actually sold for lighting, and as to the extent of electric competition in cooking. As nearly as could be estimated, no company except one which started operations in a district already covered by electricity, sold less than 40 per cent. of their gas for lighting purposes; and no company reported being able to find more than two or three electric ranges in operation on their lines of mains, and practically no electric heating arrangements. Several companies reported electric ranges placed in apartments, but replaced after a short time by gas ranges.

Those facts were transmitted to the broker mentioned in a letter, the receipt of which he acknowledged without show of much repentance.

Mr. Barnes: I happen to be very familiar with the case and it appeared very clearly that the object of the circular was to discourage investments in gas securities, and to encourage investment in electric securities. He also twisted the returns in such a way that some of the gas companies were running behind, whereas in fact the contrary was the case. I think that suggests the need for the continuance of this Committee. I do not think Mr. Forstall suggested that the Committee be continued.

Mr. W. J. Serrill (Philadelphia): The second item of Mr. Forstall's report refers to the use of gas in hat factories. My attention was called to the fact that an inspector of the Museum of Safety had reported adversely to the use of gas, claiming that poor combustion and numerous small leaks caused an odor of gas and an unsanitary atmosphere. The substitution of electric heaters for the gas burners was recommended.

Investigation in Philadelphia showed there was some truth in the complaint. The burners ordinarily used are of such design that they must be adjusted right at the burner itself, and the operatives would individually change the mixers and produce bad combustion.

A cure has been found by adopting a system in which a perfect pre-mixture of the air and gas is delivered to the burners. No local adjustment is made. The gas comes through the pipe to the burner, mixed with the theoretically correct amount of air. Personally I was old fashioned enough at first to be afraid of such systems, fearing they would fire back into the pipe system. But I now know that they are properly safeguarded.

The Chairman: It is evident this Committee should be continued.

Mr. D. D. Barnum: It is clear that the Committee should be continued, and I make such a motion.

THE CHAIRMAN: You have heard the motion, which is duly seconded. The motion is carried.

The next is the report of the Committee on Nomenclature, R. B. Harper, Chairman.

REPORT OF COMMITTEE ON NOMENCLATURE.

The Committee on Nomenclature of the American Gas Institute respectfully submits the following report.

INTRODUCTION.

Owing to the late date at which the Committee on Nomenclature was organized and the nature and extent of the work undertaken, it is not possible to make other than a report of progress.

ORIGIN.

Many of the great industries have been undoubtedly benefitted by glossaries or special dictionaries covering the nomenclature of their respective fields, but in this respect the gas industry has been at a comparative disadvantage.

It appears to be the consensus of opinion of prominent gas engineers and others interested in the manufacture or production, distribution and utilization of gas, that there is a real need for a glossary or special dictionary of the words and phrases more or less specifically used by persons engaged in all phases of the great gas industry.

This need was recognized by the American Gas Institute and led to the appointment of a Committee on Nomenclature for the purpose of preparing a special dictionary, enlarged to cover the entire gas industry, from the gas lighting glossary prepared by the American Gas Institute Committee on Gas Lighting.

OBJECT.

The Committee on Nomenclature has for its object the preparation of a glossary or special dictionary of the words and phrases which are used by those engaged in all phases of the gas industry and are not usually found properly defined or do not appear in the standard dictionaries.

The committee, while keeping in mind the foregoing general idea in its selection of the words and phrases to be defined and included in the glossary, have as their present object the preparation of a special dictionary which shall be of maximum usefulness as a book of definitions, etc., for a work's superintendent, gas appliance salesman, auditor, clerk, gas fitter, commercial agent, accountant, engineer, gas appliance manufacturer, office boy or in fact any one of the hundreds of different employees or persons engaged in any work connected with the gas business.

It will be one of the objects of the committee to keep the definitions, etc., in harmony, as far as possible, with the work done by other organizations and committees which have standardized any words and phrases in the nomenclature of the gas industry.

ORGANIZATION.

Owing to the nature of the work to be undertaken, the committee was organized with the object of securing members familiar with all phases of the gas industry in various parts of the United States and nearby countries or members who could give special service in the preparation of the glossary.

In addition, the committee has been promised the assistance of the Bureau of Standards in selecting definitions, etc., for fundamental physical or other words and phrases, etc., upon which aid is desired.

PROCEDURE.

The committee work has been laid out according to the following general plan of procedure.

(1) In absence of any desirable system of classification of the words and phrases, used in the gas industry under certain

subject heads, the following classification has been tentatively adopted:

1. Chemical Nomenclature, Apparatus, Tests, Etc.
2. Physical Nomenclature, Apparatus, Tests, Etc.
3. Electrical Nomenclature, Apparatus, Tests, Etc.
4. Constructional Materials, Methods, Etc.
5. Manufacturing Equipment, Machinery, Tools, Etc.
6. Manufacturing Raw Materials, Products, By-products, Etc.
7. Manufacturing Operations, Methods, Etc.
8. Distributing Equipment, Machinery, Tools, Etc.
9. Distributing Operations, Methods, Etc.
10. Utilization Equipment, Operations, Etc., for Lighting.
11. Utilization Equipment, Operations, Etc., for Heating.
12. Utilization Equipment, Operations, Etc., for Cooking.
13. Utilization Equipment, Operations, Etc., for Power.
14. General Nomenclature for Office, Accounting, Miscellaneous Use.

NOTE.—Manufacturing includes production (as of Natural Gas).

(2) Each member, except those selected for other special committee duties chooses a number of subject groups in which he lists all words and phrases.

(3) All words and phrases selected are typed on a standard 3 by 5 inch card in order to facilitate accuracy, ease of handling, checking and final arrangement in alphabetical order.

(4) Each member except those selected for other special committee duties, obtains, with aid of qualified associates and friends engaged in the gas industry and through other legitimate means, the best possible definitions, etc., for the words and phrases under the subject head classifications chosen or assigned to him and has these definitions, etc., typed on the standard 3 by 5 inch card.

The definitions will be classified as far as possible, under acceptable subject heads and will be preferably original. The definitions, which have been more or less standardized by various authors, associations, committees, etc., and are quoted verbatim, will appear with due credit to the authority from which they have been taken.

(5) Whenever it is deemed necessary cuts, diagrams, etc., for the purpose of explanation, will be furnished with the definitions of the words and phrases.

(6) Members will obtain as many as possible of foreign equivalents in French, German and Spanish for the English words and phrases selected for the glossary and have these equivalents typed on the standard cards just following the English word or phrase and just preceding the definitions, etc.

(7) All words and phrases together with their accompanying definitions, cuts, etc., will be arranged in alphabetical order and mimeographed for final revision and acceptance by the Committee on Nomenclature as a whole.

(8) The glossary will be presented by the Committee on Nomenclature in typewritten form with recommendations concerning the form in which it should be issued by the American Gas Institute.

While a definite recommendation has not been decided upon it has been suggested that the Institute print it in special book form and perhaps sell it at a moderate charge to cover cost of printing.

PRESENT STATUS OF WORK.

The committee members are now busily engaged in the selection and listing of the words and phrases to be defined or otherwise prepared for the glossary.

A large number of important words and phrases have already been listed and while it is yet rather too soon to know with any accuracy the total number of terms to be included in the glossary, a conservative estimate would be at least several thousand.

RECOMMENDATION.

In view of the present status of the work of the Committee on Nomenclature and the great amount of work yet to be accomplished before a complete glossary can be prepared, the

Committee on Nomenclature recommends that it be permitted to continue its work for another year.

R. B. HARPER, *Chairman,*
G. D. DODD,
D. W. FLOWERS,
EWALD HAASE,
A. HURLBURT,
E. C. JONES,
J. P. KENNEDY,
C. A. LUCKENBACH,
H. B. McLEAN,
W. E. MOCKETT,
O. E. NORMAN,
W. E. SAUNDERS,
A. H. STRECKER,
C. C. THOMAS,
A. H. WHITE.

MR. R. B. HARPER (Chicago): I might explain at the outset that this Committee was appointed because it was the concensus of opinion among various engineers that we should standardize our nomenclature. I was told the other day that the National Electric Light Association had appointed a Committee on Terminology, and asked us to co-operate with them on defining terms of common usage.

THE CHAIRMAN: Gentlemen, you have heard the report of the Committee on Nomenclature, and its recommendations. Is there any discussion?

MR. BARNES: I move its adoption, and that the thanks of the Institute be presented to the Committee.

(Motion seconded, stated and carried.)

THE CHAIRMAN: The next on the program is the report of the Committee on Carbonization. This was to have been presented by Mr. C. W. Hunter, the Chairman of the Committee. In his absence Mr. H. K. Morrison will present the report.

Mr. H. K. Morrison (Lynn, Mass.): I am sorry it has fallen to my lot to present this report in the absence of Mr. Hunter. Mr. Hunter has spent a great deal of time and thought on it.

REPORT OF COMMITTEE ON CARBONIZATION.

Section I.

The last decade has seen the development of many new ideas in the design of carbonizing plants and for the past few years the Carbonization Committee has devoted considerable time and space to descriptions of bench design and methods of operation, especially of the newer types. As a number of new installations have been made during this period, many of which embody more or less radical changes from previous designs, it was decided that an effort ought to be made to obtain figures showing the operating results of as many as possible of the more recent horizontal, inclined and vertical retort plants and by-product ovens.

The Committee fully realized the difficulty of collecting accurate information of this kind and the danger of misinterpretations of the figures if used for direct comparison between plants, without taking into consideration the conditions surrounding each one. It was hoped, however, that sufficient information could be given regarding the coal used by the different companies, methods of operation and of testing, etc., so that the figures would be of interest to a practical operator.

A letter was therefore sent to a number of the gas companies east of the Mississippi, which operated carbonizing plants, in which was included a list of the points to be covered, asking for the operating results covering a period of at least one year. Out of 28 coal gas companies, three declined to give results. The others, representing 28 separate installations, responded in a gratifying manner and the Committee wishes to express its appreciation of the courtesy with which its questions were answered not only in the first letter but also in considerable supplementary correspondence which was found to be necessary in order to insure accuracy in the presentation of the data furnished. Of the by-product oven companies only two responded, one giving actual operating figures and the other giving representative figures from a number of plants. The information thus collected is condensed and presented in tabular form in Table I.

The Committee is, of course, not in a position to vouch for the accuracy of the figures reported by the various companies.

It was thought that the statistics presented would be of interest for two purposes—first, that they would assist in the selection of new plants and second, that they would enable operators to see what efficiencies other installations of the same type as their own, were making. It must be remembered, however, that the figures represent, as accurately as we could get them, what these plants have done over a period of about a year and not, necessarily, what they could do. A direct comparison of results was found to be impossible for a number of reasons:

1st.—The conditions under which the companies were operating varied considerably. Manifestly, it is incorrect to compare directly the results from plants using different coals, meeting different gas requirements, supplying different residual markets, etc. Due weight must be given to all such points before an intelligent opinion can be formed.

2nd.—The methods in vogue in the various companies for weighing, measuring and testing the different products are not at all uniform.

3rd.—It is impossible to express some of the qualifications of the different systems in a report. For instance, the quality of the coke produced is frequently of prime importance but there is no method in general use by which it can be accurately described. The amount of smoke made is sometimes an important matter but it is impractical to try to describe its relative value in different systems.

The figures presented give as much information as could be collected in the time available, but they do not tell the whole story; all the surrounding circumstances must be given due consideration to avoid error in interpreting the results.

In collecting the data presented, the Committee was especially impressed by the large variety of methods of determining the operating figures which prevailed in the various companies. Probably the greatest difference occurred in the sampling and testing of gas for candle-power and heating value. Some plants make one test a day on the gas as it passes the meter; others make similar tests every few hours; a third procedure is to use small tanks or holders to collect a sample over a period of 8 to 24 hours and to test this as representing the average. Obviously, these methods may give widely different results on the same gas. No uniformity was shown in the manner of reporting the tar produced or the carbonizing labor. The methods of weighing coal and coke are largely dependent on the design of plant but even in the same type of installation considerable difference was noted. While a certain amount of "individuality" must be expected in this matter, it would be of great advantage to the industry if the methods were standardized by an authoritative body.

The Committee feels that in the limited time at its disposal it could not collect all the information pertaining to the subject and recommends that it be continued next year with the idea of obtaining data from more companies and in greater detail than it was possible to do this year.

The fact most forcibly brought out in the work of collecting these statistics was the great need in the coal-gas field for uniformity in the methods of testing and measuring the products handled. We recommend that the Institute consider the matter of publishing a manual which will give definite and detailed directions as to approved methods of weighing, sam-

COKE			TAR*	NH$_3$	Remarks	Plant No.
ent. arb.	Per cent. breeze	Per cent. moisture	Gal. per ton coal carb.	Pounds per ton coal carb.		
	11.5	6	11.0	4.9	es down for 3 months	H-1
& 3)	12	5	12.7	5.4		H-2
	—	—	—	—		H-3
	15	—	11.7	4.1		H-4
	16.6	7.5	12.1	5.0	er lb.) five months' figures	H-5
	15	—	12.1	5.5		H-6
	—	—	13.1	4.9		H-7
	8	—	12.0	4.3		H-8
	8.6	—	12.0	3.9		H-9
	15.5	—	13.6	4.0	benches	H-10
	14.9	4	15.1	5.4	benches	H-11
	7.2	—	13.0	4.0	benches	H-12
& 3)	16.5	—	11.7	4.9	18" x 28" cross section	I-1
	15	8	14.8	4.4		I-2
& 3)	15	10	13.2	4.5		I-3
	6	2	11.2	4.2		I-4
lant	I-1 for	Results	—	—	es through same condensing system as I-1	I-5
& 3)	8	4	9.3	4.8		I-6
	16	—	—	—		V-1
	13	0.3	15.0	4.8		V-2
	10	0.3	9.6	4.2		V-3
	15	0.3	15.0	5.2	ths figures	V-4
	10	1.0	14.9	4.8	iched by distillation of oil in retorts	V-5
	9.7	—	14.3	5.1	figures given—longest period without oil	V-6
	18.0	0.4	14.3	4.5	fig.—4 benches in opera. 7½ mos. 3b.-3½	V-7
& 3)	4	—	13.5	6.2		V-8
	3	5.0	14.0	6.2		V-9
	—	—	14.5	—		V-10
	4	3	8.3	5.9	ted to be typical results of several plants	O-1
	5	—	6.0	4.8		O-2

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pling, analyzing and measuring coal, coke, gas and the other products which are produced in carbonizing plants.

SECTION II.

The increasing production of coal gas has brought the coke business into greater prominence than ever before. Your Committee, therefore, has made a study, in a general way, of the means adopted by the principal companies for marketing and delivering this product, especially of handling it from retorts to storage pile. Table II gives the information received in answer to a list of questions sent to various gas companies. No attempt has been made to describe the details of the mechanical equipment as the scope of this table has been restricted to general information only. The data is presented in tabular form, divided into types of plant for convenience in reference. From this table, the manager of a company which is considering entering the coal-gas field or adding a new unit to an existing installation, can see at a glance the methods which other representative concerns have found advisable to use in marketing their coke and delivering to the consumer. Furthermore, the general layout of the conveying, screening and quenching systems adopted by operators of the four principal types of carbonizing apparatus, can be readily reviewed.

C. W. HUNTER, *Chairman,*
W. H. BLAUVELT,
O. B. EVANS,
DONALD MACARTHUR,
H. K. MORRISON,
O. A. SINSEL,
F. W. SEYMOUR,
Committee on Carbonization.

LIST OF QUESTIONS ON OPERATING RESULTS OF CARBONIZING PLANTS.

NOTE.—*All figures should cover a 12 months period or as near this as possible. All figures should refer to same period of time. Weights of coal should be given "as charged," i. e., moisture included and expressed in lbs., or ton of 2,000 lbs.*

1. Number of benches (or ovens), type, size, kind of refractory material and date of installation.

2. Average weight of charge; carbonizing period; average and maximum temperatures in combustion chamber, around retorts and at outlet of recuperator. (How are temperatures taken?)

3. Normal maximum capacity of plant in net tons of coal per day. (That is, assuming the gas send out sufficiently large to take all the coal gas made, what would be the average daily tonnage charged over a period long enough to include complete scurfing of retorts.)

4. Type of producer, size and kind of grate and kind of bench fuel used.

5. Brief description of coal and coke handling equipment.

6. Kind of coal charged and tonnage of each kind used with its average proximate analysis during twelve months period. (Is coal actually weighed and at what point? Are any corrections applied to weights given?)

7. Cubic feet of gas produced per pound of coal during twelve months period. (Is gas corrected to 60° F.?—to 30 inches barometer—for holder pressure? If not corrected for holder pressure what is the average gas pressure at meter.)

8. Average candle-power of gas during twelve months period. (What kind of burner was used? What kind of standard, *i. e.*, Edgerton, Elliott, pentane lamp, etc.? How many times in twenty-four hours is C. P. taken? Is sample holder used?)

9. Average analysis of gas and specific gravity.

10. Average number of gallons of tar recovered per net ton of coal charged during twelve months period. (If moisture in tar is over 2 per cent., please give amount. Also give analysis of tar if available, and specific gravity.)

11. Number of pounds of NH_3 (or gallon-ounces of liquor or pounds of sulphate) recovered per net ton coal over twelve months period.

12. Pounds of bench fuel per 100 pounds coal carbonized (or cubic feet gas used under ovens per net ton coal) during twelve months period. (Is bench fuel weighed or estimated? What percentage of moisture does it contain?)

13. Total net tons coke available for sale during twelve months period. (What is average percentage moisture in coke? What is average percentage of breeze?)

14. Labor required in retort house (or ovens) per day from point coal is received into house until coke is delivered outside house. This includes work of charging, discharging and scurfing retorts or ovens, quenching coke, cleaning hydraulics and standpipes, charging and clinkering producers and removing ashes, regulating temperatures and pressures and such part of foremen's time devoted to superintending this work. Labor of making producer gas analysis should be included, but not coal and coke analysis and routine chemical work. Give labor in hours per day.

15. Total production of coke and ratio to coal carbonized.

THE CHAIRMAN: You have heard the report. Part of the suggestions will be covered in the paper on Standard Tests. The paper is now open for discussion.

MR. W. E. STEINWEDELL (Cleveland, O.): In the report of this Committee it would seem that the results should have been classified in Table I to sub-divide continuous verticals and intermittent vertical retorts.

The following table has included these subdivisions and gives an average of the principal results of Table I of this Committee.

While incorrect to compare results directly, the averages are of interest and bring out some important points:

TABLE I.

AVERAGE RESULTS FROM MR. HUNTER'S REPORT.

Type of plant	No. of plants	Capacity tons coal per day	Candle power gas	Cu. ft. gas per lb. coal	Coke made	Tar per ton coal	Ammonia per ton coal	Per cent. gen. fuel of coal carbonized	Hrs. labor per ton coal 24 hrs
Horizontal through's	7	112	16.1	5.31	66	12.3	4.9	13.7	1.0
Horizontal stop ends	5	96	14.	5.26	66	13.1	4.3	17.8	1.9
Inclined retorts	6	103	15.8	5.29	66	12.	4.56	13.3	1.1
Continuous verticals	7	86	15.8	5.27	69	13.8	4.8	15.3	1.1
Intermittent verticals	3	86	17.5	5.33	66	14.	6.2	15.3	1.1
Coke ovens	1	950	14.9	5.50	70	6.	4.8	50% lean gas	0.4

It will be noted with the exception of the coke ovens, that the average sized plant in each case is of about 1,000,000 cubic feet daily capacity; that the most coke is made in the continuous vertical retorts; that the most tar and ammonia is made in the intermittent vertical retorts, and the least generator fuel is required in the inclined retorts.

The horizontal through retorts require about 1 hour of labor to carbonize 1 ton of coal, and the inclined retorts, continuous and intermittent vertical retorts require about 1.1 hours of labor per ton of coal carbonized.

In addition to the above types of carbonizing plants, there are now in operation two installations of inclined gas ovens and another installation of about 2,000,000 cubic feet daily capacity is now building.

The results from these plants are not as yet available, but the quality and yield of the products and by-products are excellent, and the labor required is less than the amount given in the above average table.

It seems most advisable to continue this Committee next year, and for the Institute to publish a manual of approved methods of testing as recommended by the Committee.

The Committee certainly deserves the unanimous thanks of the Institute for the great amount of work done in preparing this report, and the excellent manner in which it is presented.

Mr. J. H. Taussig (Philadelphia): It is important for a gas manager, in studying various systems of carbonization, to get accurate figures that will enable him to judge the relative merits of the plant.

It is evident, in looking over the tables in this report, that many items are given which do not represent average conditions. Candle-power results are given where one, two or three readings are taken a day. Such results, of course, give no indications as to what the average candle-powers were and are therefore very misleading.

Residual figures given may give a little better line on the capabilities of the plant in that direction, but it is obvious that, where coke is sold by weight, that there might be a large discrepancy due to moisture content. Bench fuel figures on estimated or test conditions are of no value. To make such a report of any value at all, it would be wise for a gas manager interested to go to the various plants and see how the results were obtained.

MR. E. Y. SAYER (New York): The report was received so late that I did not have time to give it any study. It shows the need of getting down to some basis. The report shows such a variation in results here that one could hardly believe them.

I think the work should be continued, with the idea of standardizing some of the results of the Committee.

MR. J. A. PERRY (Philadelphia): It seems to me that anyone contemplating the purchase and installation of a coal gas plant should give careful consideration to the results which are now being obtained from installations in use. From these installations we can easily see that some plants obtain a yield of from 2 to 3 gallons more of tar per ton of coal carbonized. One more gallon of tar per ton of coal on a plant carbonizing 100 tons per day, and operating 365 days per year, amounts at 3 cents per gallon to $1,095 per year. With interest, taxes and depreciation at 10 per cent., an additional investment of $10,950 is justified.

Now, the tables exhibited by the Carbonization Committee show that we can expect some plants to give from 1 to 2½ pounds more ammonia per ton of coal carbonized than other types of plants. On a plant carbonizing 100 tons of coal per day, 1 pound increase yield of ammonia per ton of coal carbonized amounts to 100 pounds of ammonia per day. This at 8 cents per pound net gives an increased revenue of $8.00 per day, or $2,920 per year, which would justify an additional investment of $29,200. If the yield of ammonia is greater than 1 pound additional per ton, then the additional investment justified is proportionately greater.

The tables submitted also show that the amount of breeze on some systems runs from 11 to 16 per cent. of the coke made. Other statements show, where the coke is hard, that the percentage of breeze runs very much smaller. It is easy to see that the lump coke for sale might be increased at least 60 pounds per ton, due to less breeze made, and that the net value of the lump coke over breeze used for boiler fuel, would be at least $2.50 per ton. On a plant carbonizing 100 tons per day, the extra returns due to increased lump coke would be 3 tons per day, which at $2.50 per ton or $7.50 per day, amounts to $2,738 per year, justifying an increased investment of $27,380.

Mr. H. C. Porter (Pittsburgh, Pa.): I would like to say a word from the standpoint of by-product coke ovens for gas manufacture. I notice that the column in the table headed "Retort House Labor per 24 Hours" is practically the only place where an idea of cost of operation is given. This illustrates the importance of the caution the Committee has given as to interpreting the report according to special conditions at different kinds of plants. The size of the plant and therefore its output both of gas and coke per 24 hours, affects, of course, the total labor cost per 24 hours and it seems that an item should have been given in the report showing not only the total labor cost per day, but the cost per unit of output.

The Chairman: Is there any further discussion?

Mr. O. B. Evans (Philadelphia): (Written discussion communicated.) The ultimate object to be desired in the choice of a carbonizing plant is, of course, the production of the lowest priced gas, all items being considered such as interest, depreciation, labor, repairs, etc. It is unfortunate that due to local conditions affecting the cost of plant, cost of labor and residual return, such typical figures cannot be given.

Attempts to compare the operating results obtained upon different coals and upon different plants may be misleading, unless all the local conditions are accurately determined. For example, it may be unfair to compare candle-power and calorific value readings from one plant in which gas for these readings is collected in a sampling tank over a period of 1 to 2 hours, with one in which snap readings are taken may be once or twice a day. It is well recognized that capacity has a material effect upon the character of the gas produced, and probably upon the residual yield, and a plant may at the sacrifice of capacity produce apparently very low cost gas.

To those familiar with the installations, a careful study of the tabulated figures will show which plants are operating at high capacity and which are operating at low capacity, and due allowance for such conditions should be made in any estimate as to the probable value of any particular type of installation.

MR. F. C. FREEMAN (Philadelphia): Mr. Steinwedell's comparison of the results obtained in various systems of carbonization show the apparent advantage of the inclined retorts over all other systems in the amount of furnace fuel used per 100 pounds of coal carbonized. In arriving at this conclusion I think that he has based it on results which are open to question.

You will note that all of the furnace fuel for inclined retorts is estimated, whereas the furnace fuel for vertical retorts in every case but one is weighed. In the one case where the furnace fuel was weighed for inclines, the results show higher than in a comparison with verticals.

THE CHAIRMAN: It has been moved and seconded that the report be received and adopted. Is there any further discussion? If not, those in favor please vote aye. Carried.

The next paper is: "How One Gas Company Handles Its Coke Business." Mr. Seymour was a member of the Committee on Carbonization and prepared the paper for the Committee. The Technical Committee, however, requested Mr. Seymour to make an independent paper on the subject.

Mr. F. W. Seymour (Grand Rapids, Mich.): I shall just read an abstract of the paper which I have prepared. Our system has been developed to meet the peculiar local conditions which we have, and which other companies represented in the Institute may meet from time to time.

HOW ONE GAS COMPANY HANDLES ITS COKE BUSINESS.

The general subject of coke, though widely discussed, has not received the amount of attention it deserves. This is due to the fact that the amount of coal gas made in this country is still comparatively small in volume. Of the total artificial gas manufactured in the United States each year about 75 per cent. is still carbureted water gas. Economic conditions have, and will continue to decrease the amount of this in the future, supplanting it with coal gas made in the various types of equipment at present used, and in the future to be developed for the purpose. If this were to become 100 per cent. coal gas, the amount of coke incident to the production of this volume of gas would not become of overwhelming importance as the market for a solid fuel of the smokeless type is amply large to absorb this, and it is continually growing. There is produced each year in the United States about 80,000,000 tons of anthracite coal, part or all of which can and will be displaced by coke. Even though competition did not bring this about, the exhaustion of the hard coal fields, in time, would. A further field which is opening to retort and by-product coke is the enormous amount made by the wasteful beehive process. The 1915 figures show that of a production of approximately 41,000,000 tons of coke produced in this country only 14,000,000 were produced by by-product equipment. The combined tonnage of this beehive coke and anthracite coal and the future increase in the market, due to increase in population in this country, show infallibly that a practically inexhaustible market for by-product and retort coke exists; and that the movement to coal gas manufacture, which received considerable impetus in 1913, is not temporary and will probably be accelerated as it progresses.

Temporary additional spur has been given this movement by the unusual returns from the sale of residuals resulting from coal gas manufacture. The underlying conditions being induced by the great European war are not seemingly those of permanency but have nevertheless been partly responsible for the building of much coal gas equipment.

Typifying the development due to these causes, in the following will be given a description of the coke system of a plant distributing 93 per cent. coal gas made in horizontal retorts. The coke resulting from the manufacture of this gas equals, approximately, 60,000 tons per year. Ninety-eight per cent. of this amount is sold to the domestic market. The real importance of this market is shown by the fact that the retail value of the coke sold in this manner is equivalent to 40 per cent. of the retail value of the gas distributed by this company. Although the sales of coke per capita in this case are much higher than is usually encountered, this plant is described because it was in the same situation several years ago that many plants are meeting now, namely, mixed gas was distributed, sufficient water gas being made so that only enough coke was produced to take care of the business which came to the company without any effort. The rapid rise in the cost of the raw materials entering into the manufacture of water gas modified the situation so quickly and so completely, that it was necessary to displace water gas with coal gas, and build up a market to dispose of the additional coke produced. Another reason that this particular plant is described is that there is more diversity of the type of equipment than is usually encountered.

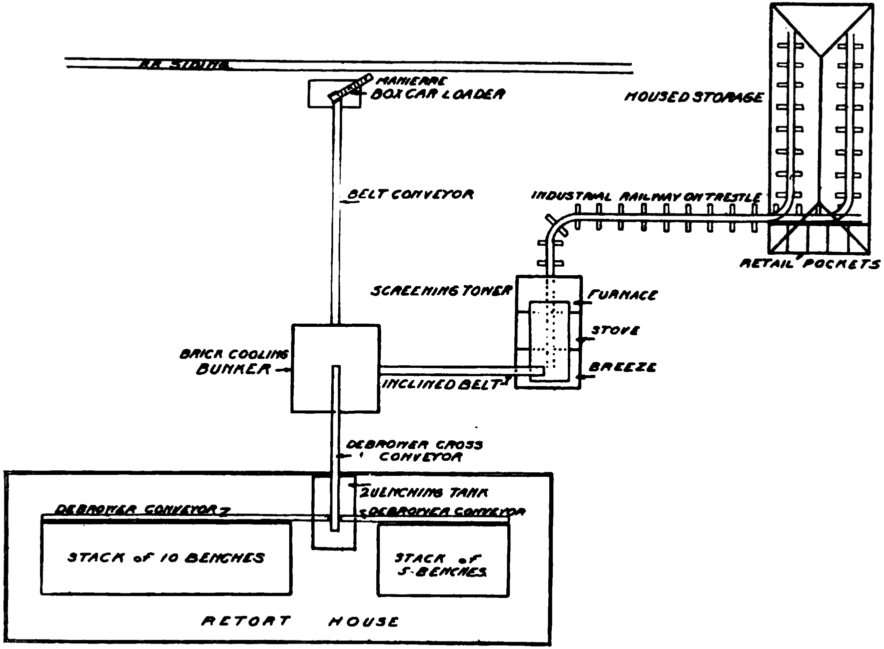
The reasons for the adoption of the particular equipment and the policies put in force are given, as being of more importance than an elaborate description, inasmuch as the latter would be more or less familiar to members of the Institute.

It has been attempted to give the bad features as well as the good, so that the following will be of greater value.

Fig. 1 is a layout showing the method of handling coke from the benches to the retail pockets. The generating equipment consists of two stacks of benches, fifteen in number, of 22-foot horizontal through 8's, with D-shaped retorts, the whole being of the latest and most improved designs. These are served by DeBrouwer hot coke conveyors which run on the discharging side and convey the coke to the DeBrouwer inclined cross conveyor operating between, and at right angles to the two stacks of benches. This drags the coke through a quenching tank and carries it up an incline into a 20-ton cooling bunker of firebrick and steel construction. From the cooling bunker the coke may leave being screened and sent up an incline belt conveyor to the car loading dock. Here it may be spouted into open type cars directly, or loaded into box cars by means of a Manierre 16-inch belt box car loader. When cars are being loaded with furnace coke, the screenings from the shaking screen employed under the cooling bunker are conveyed to the screening tower by means of another belt conveyor. This conveyor also serves as a run of make conveyor, when cars are not being loaded, taking the coke from the cooling bunker to the screening tower.

In the screening tower the coke is separated into three sizes, *viz.*, furnace, stove, and breeze. Furnace consists of all coke passing over a 1½-inch square mesh screen. Stove is that passing through a 1½-inch and over a ¾-inch screen. Breeze is that portion which passes through a ¾-inch screen, being all burned at the plant.

From the tower the coke is conveyed by a manual industrial railway, with 1-ton tipple cars, either to the retail pockets, of which there are five, with a capacity of 40 tons each, or is dumped over trestles into stock. It is considered necessary to house only sufficient coke so that during severe rain or snow storms the coke which has temporarily become saturated and which later will dry out, is not loaded for the trade. Further



GENERAL ARRANGEMENT of COKE HANDLING SYSTEM.

FIG. 1.

than this, housing is not valuable and only need be a small percentage of the total storage.

The maximum stock is equivalent to between 15 per cent. and 20 per cent. of the yearly sales, and is recovered entirely by the use of wagon loaders equipped with shaking screens which load the coke directly into wagons or trucks.

When the first and larger stack of benches in the plant was built, it was equipped with quenching chutes with perforated pipe sprays inside for the coke handling and quenching system. The coke after being allowed the proper drying and draining period was taken from the quenching chutes, by industrial railway, to the feeding hopper of the belt conveyor, which was equipped with the reciprocating plate feeder by which means the belt was loaded.

When the quenching chutes were due for replacement the experience we had gone through did not warrant a duplication of them, and a system of DeBrouwer conveyors was installed approximately as shown in the accompanying sketch.

The primary reason in mind for the selection of this DeBrouwer conveyor system was coke quality. All other advantages were incidental to this main requirement and were not held as deciding considerations. The disadvantages were weighed and found important but not serious enough to counterbalance the good points. In any event the selection of coke handling equipment for a retort plant is one of compromise and the system chosen may be decided upon for negative reasons rather than positive. In other words, the DeBrouwer conveyors were chosen partially because they had less serious disadvantages than some of the other methods of handling and quenching hot coke.

This device, so thoroughly familiar to all gas men, requires but a brief description. It consists of a double chain connected by cross bars or drag strips placed at frequent intervals, the whole being dragged in a steel or cast-iron trough which has been lined on the inside with very hard white iron wearing plates. A small amount of water is run in the trough for cooling and for lubrication of the chain and the lining plates. The return of the chain may be over or under the trough as the demand of space limitations may dictate. The whole is operated through large sprockets which in turn are driven by equalizing gears so designed as to compensate for the long pitch of the chain. This is found necessary to convert the constant angular velocity of the driving motor into the constant lineal velocity of the chain, as the latter in leaving the sprocket would give the chain a jerky motion, which is not to be desired. The conveyor is run at a speed of approximately 60 feet per minute.

The advantages and disadvantages of the DeBrouwer hot coke conveyor are as follows:

Advantages:

1. Quenching is made uniform and is under control.
2. Combining of the functions of quenching and conveying.
3. Adaptability to any speed and capacities of routine.
4. Reduction of labor.
5. Elimination of steam from retort houses and the bettering of working conditions.
6. Breeze and fines are not washed away with quenching water.

Disadvantages:

1. Coke breakage is severe.
2. Power and maintenance are large items.
3. Interruption to routine in case of breakdown.
4. Safety hazard.
5. High first cost.

Though there is vast disagreement among authorities on the proper methods of coke quenching, the following points seem to be essential. In order to produce a coke, which in domestic furnace coke will have a moisture content of not to exceed 6 per cent. and to possess as gray a color as possible, quenching should be done quickly over a layer of coke which is not too thick and with an excess of quenching water. Further, sufficient water must be used to extinguish all fire in it, leaving the interior carrying sufficient heat to evaporate the moisture that is in the outer shell. This implies, in this installation, the quenching and conveying of the coke as rapidly as possible from the zone of quenching operations. The possibilities of meeting these conditions and producing a uniformly quenched product have been vastly augmented by the addition of a quenching tank. Fig. 2 shows a quenching tank similar to the one installed at this plant. It consists of a sheet metal tank 6 feet 6 inches by 20 feet by 24 inches. The water level is under control by means of adjustable over-flows, which determine the length of time the pieces of coke will be in contact with water.

Formerly, on DeBrouwer conveyor installations, the quenching was done by means of a quenching spray which quenched the coke in the conveyor trough, either as it left the retort or at some distance from there. When quenching is done on a conveyor which serves a number of benches the efficiency of quenching becomes a function of the distance of the retort being discharged to the quenching nozzle, as the coke will gradually string itself out in the conveyor trough until it comes to a given cross section. This, of course, is not true of intermittent vertical plants which have a feeder on a larry which receives the coke from the retorts and feeds it into the DeBrouwer conveyor. It likewise would not be true were it possible to make the speed of the pusher at all times such that the coke would discharge at exactly the same rate that the conveyor would withdraw it with the desired cross section. This is not practical in ordinary practice, and even if it were, there would still remain the difficulty of the charges breaking off in irregular lumps. The use of a deflector or plate to distribute this coke on the conveyor is also impractical as the liability of wedging of the large pieces of coke, which would cause serious breakage, is present. There are other reasons for doing the majority of quenching elsewhere, the most important of which is the desire to keep the steam out of the retort house.

In this installation the quenching tank acts as a receiver for

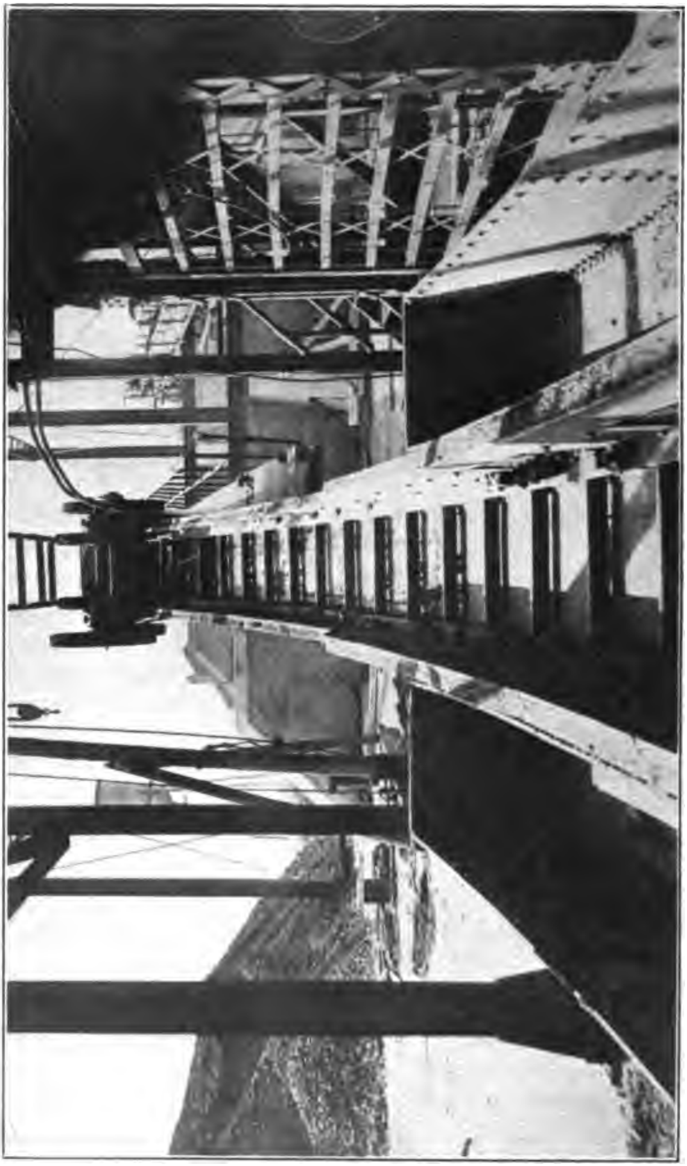


FIG. 2.

the discharge of the two bench conveyors, the cross conveyor running through it. A plate over the travel of the chain serves as a valve regulating the cross section of the coke taken through the tank. Inasmuch as the speed of the chain is constant, and the length of travel through the water is likewise, this device having made the amount of coke per foot of chain uniform, the length of time of contact with the water will be the same for all pieces of coke. Further, the greater the mass of a piece of coke the greater will be its surface, and consequently the more water it will be treated with.

It is then necessary only to so regulate the water level that the coke will have been penetrated by water in the time submerged that that heat remaining in the lumps will vaporize this excess. In practice this method of quenching has worked out so that the moisture content can be kept well under 6 per cent., which in this locality is considered commercially dry fuel. On a test run covering two weeks the domestic furnace size showed an average of 2.9 per cent.

An incidental advantage of this system is a considerable saving in the amount of water used for quenching. The advantage of this system, by combining quenching and conveying, is indirect, as it makes the other advantages possible and saves space. It also makes it possible to get it in many installations where it would be impossible to have other systems.

The adaptability of this conveyor is an especial point of value. It is compact, occupying only a space 15 inches by 36 inches for the trough which is conveniently located either outside the producers or on top of them. The return run of chain can be made over head or below the floor level, depending upon space limitations or interference with other operations. The discharge accommodates itself well to any layout, being simply a hole in the bottom of the trough, also being very favorable to proper treatment of the coke, as it receives no velocity in discharging other than that due to gravity. One conveyor could be easily made to serve 200 retorts, and is sufficiently rugged to take large temporary over-loads without injury. It is very conservatively rated at a speed of 60 feet per minute, as this speed can be increased considerably if additional capacity imperatively demanded it.

By virtue of its ability to better working conditions the hot coke conveyor will reduce labor. It further increases production per unit of labor by completing the routine simultaneously with the completion of the round. This makes the task of firing producers, opening and closing the lids, and other stoker's work the only tasks for the labor connected with it, and the work per man can be thus better apportioned and regulated. When men working in the heat are compelled, after their duties are finished, to do work of another nature, the efficiency of operation always suffers. Further, and to the point, this conveyor displaces hand labor for the handling of coke which in all conditions results in a saving.

The DeBrouwer conveyor does not eliminate steam. No system using water to cool incandescent coke can. It does, however, remove it from the zone of operation in the retort house and concentrate it where it can be properly handled by ventilators if need be. Usually the quenching tank, or the quenching nozzle, of the bench conveyor is located at the point where the conveyor leaves the retort house so that all steam is taken out of doors. This is a very important assistance toward labor saving, as all men, whose duties in the retort house are such that they are working while coke quenching is being done, are hampered if steam is allowed to drift to them. This applies particularly to clinker and coal conveyor men. The removal of steam thus eliminates a very bad hazard and the extremely rapid depreciation of all steel work around the buildings with which it comes in contact. This latter advantage is one of which the immediate effect, of course, is not capable of precise estimation.

The quenching tank in this layout is sufficiently large that the breeze and fines, which are usually washed away, are settled and retained within it. In handling this material, ordinarily a large settling basin is necessary, which must be periodically and frequently cleaned, for if allowed to flow into the sewers it is lost, and sometimes causes very annoying stoppages. With any system, the breeze recovered is wringing wet, but air drying is sufficient to make it usable in the boiler plant.

There is considerable option allowed in the choice of details in the DeBrouwer conveyor. A steel supporting trough lined with white iron wearing plates may be used in preferance to the cast-iron trough in this plant. Again a short pitch chain may be used, by reason of which it is considerably lightened, and the first cost reduced accordingly. Likewise, the size and speed is optional with the engineer purchasing one. The correct answer to the question of details is only to be had by reports from the various installations in use which have chosen differently on these points.

As opposed to the advantages of this system are the bad points listed in their order. Theoretically and fundamentally the DeBrouwer conveyor is at variance with most ideas for the conveying of coke. Coke is sufficiently brittle to be badly broken by dragging over a metallic surface, and sufficiently abrasive to do some very effective scoring while undergoing this treatment. Illogical though it seems, a good many gas companies are doing just these things, and the number is constantly increasing. The reasons for these crimes against both the conveyor and the coke are, however, those of degree. They are reduced very materially by the use of some water in the trough which serves a double purpose; it cools the conveyor and lubricates it, particularly the latter. The question is relative in that gas retort coke is so very fragile that any system of handling, even though operating at its best, is very conducive towards growth of the breeze and small coke piles.

In this plant the conveyors have not been operated long enough to get actual comparisons of the breakage due to them. We do know, however, that the breakage is greater than with the former method of handling by means of quenching chutes and belt conveyor. Apparently the excess breakage is shown by the increase in the small grades of salable coke rather than in the production of breeze. The returns from other plants do not throw any light on this, as so many other variables must first be determined, such as other kinds of coals, temperature of carbonization, types of equipment, etc. Tests for breakage are of little value as they do not represent a diversity of conditions such as are found in normal operation.

As in the case of coke breakage, the period of operation has scarcely been long enough to show any reliable figures on maintenance. The wear and tear on the chains give every indication, however, that the maintenance of these conveyors, and especially the cross conveyor, is going to make them more expensive than the use of quenching chutes or quenching buggies. The current consumption on the two motors driving the bench and cross conveyors is about 0.8 kilowatt hour per ton of coke handled.

Any mechanical device may, and does, break down. Hot coke conveyors are no exception. It would be prohibitive in cost to have extra conveyors or spare units for this work even if they could be installed in the space available. Consequently, in case of breakdown it is necessary to make the repairs as quickly as possible and handle the coke by hand until that time. The simplicity of the moving parts of the conveyor, and the very rugged and ample construction of them, makes breakdown a very rare occasion, however.

The use of a chain running over sprockets and in an open trough near workmen, who are working at arduous tasks under very unfavorable conditions of temperature and ventilation, is no doubt a hazard of considerable importance. There are, however, other unavoidable hazards around gas plants, that by the fact of their being dangerous, arouse an increasing amount of caution with the workmen exposed to them. The proper protection of all sprockets, gears, and exposed runs of chain, help to eliminate this especially when assisted by the inculcation of the habit of safety in the men.

The high first cost of the DeBrouwer conveyor system is purely a relative and comparative matter and hence must be decided as such, with reference to local conditions. The normal first cost is somewhat increased by the necessity of carrying a complete stock of spare parts.

Fig. 3 is a picture taken of one of the bench conveyors,

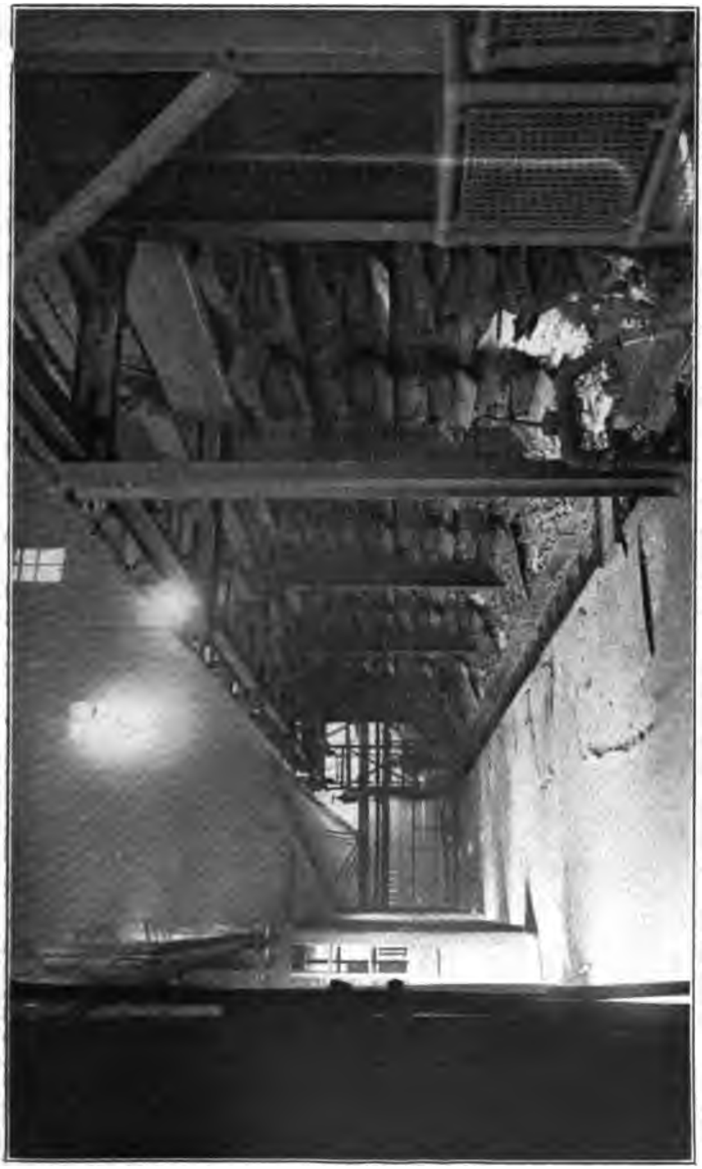


FIG. 3.

looking from the location of the cross conveyor and quenching tank. The return run of chain is carried on cantalever beams bolted to the buckstaves of the benches.

The cooling bunker shown in Fig. 4, is made of steel and firebrick, and is of about 20 tons capacity, which is sufficient for slightly more than one round or draw of the benches. This is made of this size for several reasons, all seeking to better coke production. The product going into this bunker may be so quenched that during its period of repose here it will drain considerably. If the bunker held coke which had been previously cooled and drained under it, this latter product would only receive excess water from the process. This obviously has been avoided by allowing only the coke from one round in the bunker at a time. Again, the larger this bunker were built the greater would be the breakage due to the fall into it and the crushing and erosive action due to the extreme height. To obviate the breakage, this bunker is always kept full of dry coke, the belt conveyor feeders at the bottom only removing it as fast as the run of make is being fed in at the top, this minimizes the fall into the bunker. It has been found essential and necessary to employ a cooling bunker as a place for the quenched coke to dissipate the heat on the inside of the pieces of the product and to vaporize the excessive surface moisture. The ideal condition in this case is to have the mass of coke come to equilibrium at the point where the moisture content is, in the domestic furnace coke, as near zero as possible and the temperature of the mass that of the atmosphere. If a long period of drying and draining is not allowed, the pieces which are still hot in the core will, if fractured later on in the handling system, blaze up at any opportunity.

Woven wire manganese steel square mesh screens are in use, mounted on wood shaking frames. The gravity or stationary incline screen has proven by years of use that it is totally inadequate to produce a properly screened product even though operated with the best care and intelligence. The rotary screen which is so much used for anthracite coal

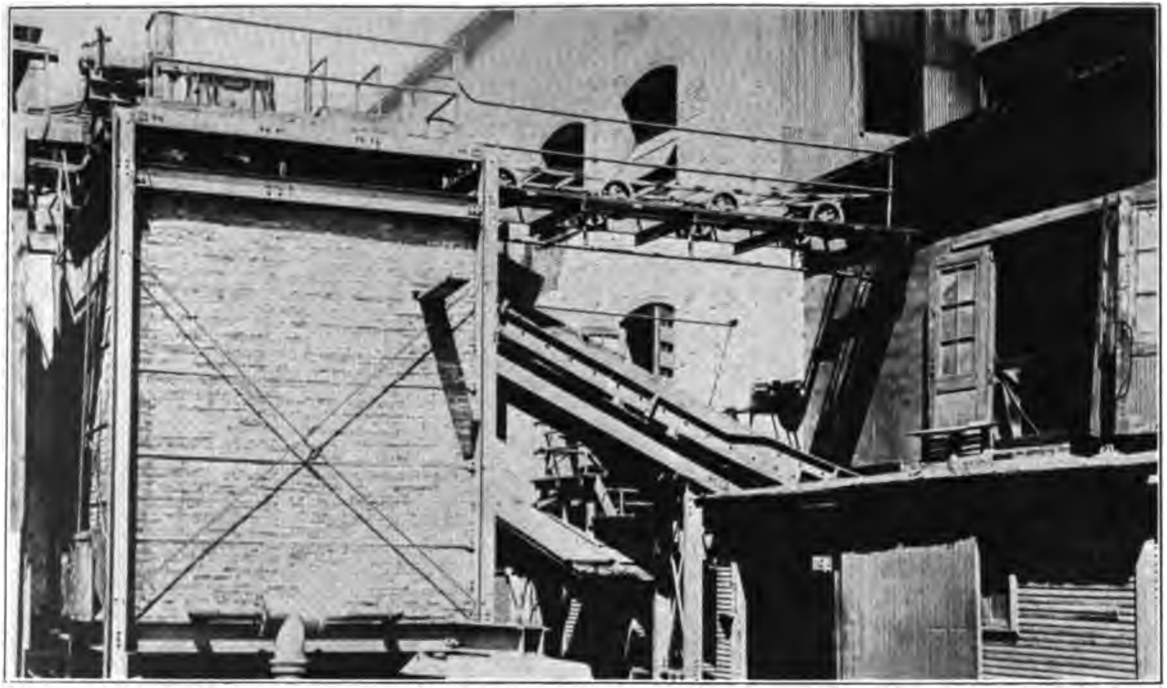


FIG. 4.

sizing and for by-product coke preparation was found entirely too rough on horizontal retort coke which is produced at this plant. The space limitations under the cooling bunker for screening coke to cars also prohibited the use of anything but the shaking screen, even if any other type were desired. Experience has gradually taught the use of wood frames for shaking screens, inasmuch as the weight of the reciprocating parts are very materially reduced for the same area of screen as when supported with metal. By so building them that the wood members form the compression elements, and so jointed and held together by bolts with ample washers for bearings forming the tension members and frame, infinitely more service is given and less repairs are necessary than with a metal frame. The choice of hanging the screen frame from cables or wood supports, or setting it on top of vibrating strips is very much a question of local conditions as either of the methods are suitable. It has been found very difficult to keep shaking screens in successful operation in any of the high buildings as the vibration set up in the structure tends to loosen the structural members. With the rapid improvements that are being made in this type of equipment, however, a standardized type suitable for use in most places, no doubt, will soon be available.

Manganese steel screens have been in use for about 3 years and the choice of this high-priced metal has been well justified. It gives several times as much tonnage per square foot of screen as the steel in general use for this purpose. By making frequent renewal, with the consequent interruption to service, and the occasional repairs incident to this class of service unnecessary, the use of manganese steel has brought about reduced tonnage cost per foot of screen. Experience here has been, that for domestic trade, bar screens allow too many pieces which are over size on one dimension to slip through. On account of the decreased weight woven wire is used in preference to plates. The heavy plates increase the weight of the reciprocating parts on the shaking screen too much to be practical, and the cost of high priced manganese steel makes it necessary to keep the weight per square foot at a minimum. Also the wire mesh gives much greater percentage of screen area, or holes, per square foot of total screen surface than the plate type.

The 24-inch belt conveyor is the medium used to convey the coke from the cooling bunker to the coke screening tower or to the car loading equipment. Fig. 5 shows such a belt in service conveying screened coke to the latter place. The belt conveyor is very widely used with perfect satisfaction for conveying and elevating coke in by-product oven and other plants, but has met with very little application in retort installations. The reasons are not apparent why, and with the increase in the number of coal gas plants there is sure to be a program in the future for wider application of this device in gas plant work. The particular point of merit is that it is very easy on coke, inasmuch as there is no movement of material with respect to the belt while being moved from one place to another. The only breakage suffered by coke is in feeding on and discharge from it. Sometimes the discharge in particular is rather prolific for breakage, as the coke has achieved some velocity with high belt speeds. The mechanical simplicity and low first, or installation, cost are very meritorious points in favor of the belt conveyor, and it is also capable of enormous conveying capacity. The 24-inch belt conveyor, when running at 200 feet of belt speed per minute, can handle in excess of 40 tons per hour, and belts of this type are capable of running considerably over 300 feet per minute.

Another point of advantage in the belt conveyor is its safety from the accident standpoint. This means freedom from mechanical accidents to the belt itself, as well as the elimination of personal accidents to men working about them. This feature of reliability is, of course, due to the mechanical simplicity and should appeal very strongly to the gas plant operator

With the exception of the item of attendance which involves oiling, cleaning up—amounting to a very small expense—the two items entering into the operation of a coke conveying belt

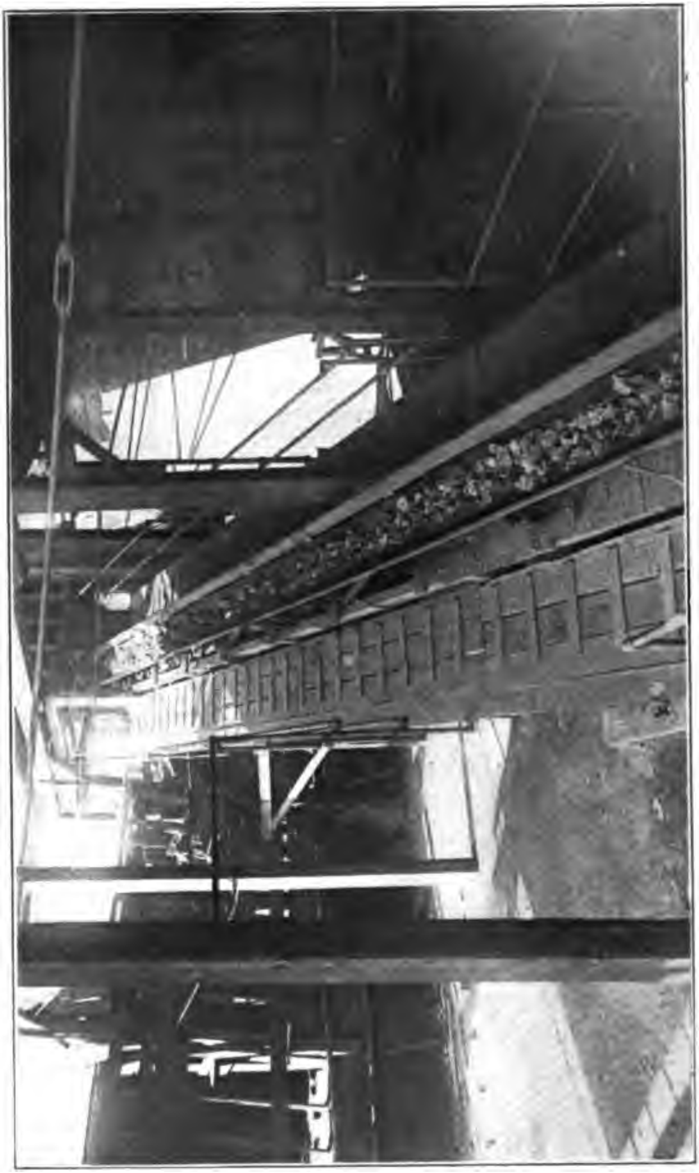


FIG. 5.

are power and belt renewal. The power item is very small indeed. Elevating coke by means of the 24-inch belt, mentioned above, a vertical distance of approximately 60 feet, uses power at the rate of approximately 0.2 kilowatt-hour per ton. This, of course, is so small as to be almost negligible.

The troubles experienced with belt conveyors in service conveying gas coke have their origin in the nature of the belt or fabric. The belt will, after considerable use, absorb water from breeze in carrying run of make, and when shut down during the idle periods in the winter months, freeze up. Thus when put in operation—which is difficult; as the belt lacks grip and the resistance to rounding the pulleys is considerable—the fabric is thawed out from the warm coke coming on it with the consequent deterioration of the same when alternately exposed to this for long intervals. Also the abrasion of the coke on the fabric is very severe. The danger of slip up in operation permitting hot coke to get on the belt is always present which would, of course, be disastrous in the extreme. The belt conveyor is sometimes very inconvenient to adopt, as it is a straight line proposition and cannot be run at more than a 20 degree pitch.

On account of these conditions the tonnage per square foot of belt is considerably less than that obtained when conveying other materials. The belts in this plant have been in operation long enough to strike a reasonable average of performance. Fifty-five tons per square foot so far has been representative for a six-ply belt. Bearing this in mind it can be said that the belt conveyor is satisfactory for the purpose for which it is used.

About 400 box cars per year are loaded by means of a Mainerre, 16-inch belt, box car loader. Fig. 6 shows a photograph of this device as it is installed at this plant. It has been extremely satisfactory in the saving of expense attached to loading box cars, as it has reduced this item from the loading by hand approximately 60 per cent. The belt speed on this device is rather high as it projects or throws the material into the far corners of the car, and, as a consequence, there is some

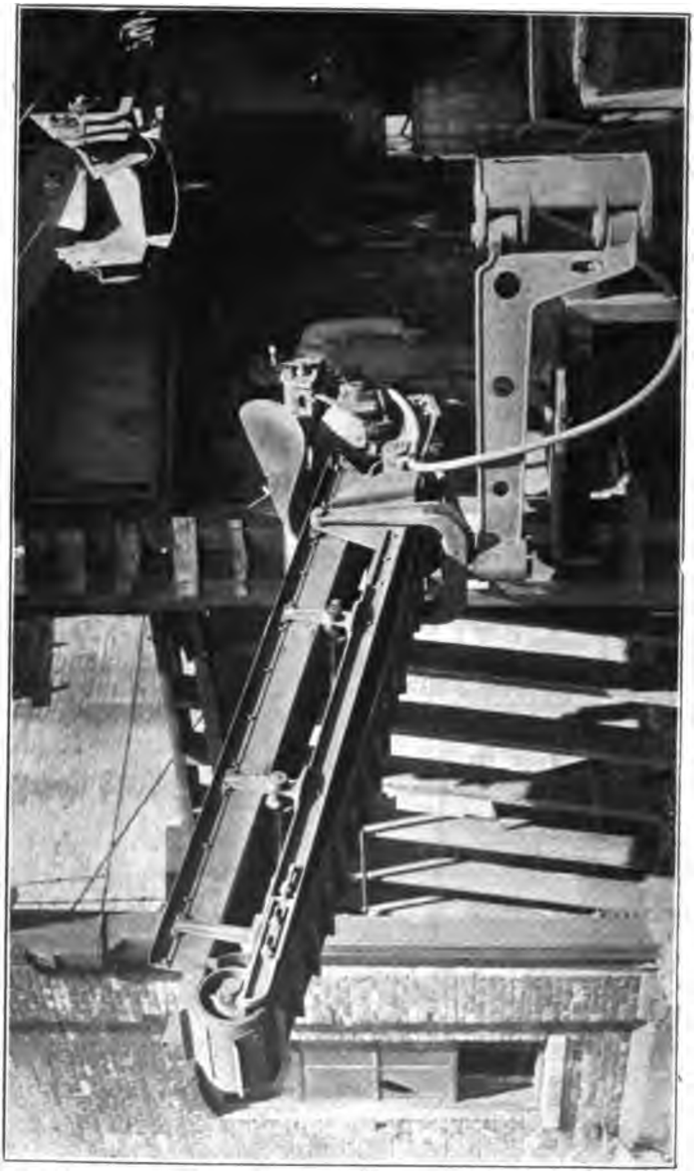


FIG. 6.

breakage attached to its operation. This item, however, is not large enough to be objectionable. It has also been of considerable value in providing the best of service in the loading of cars an important point in holding the good will of the dealers with whom the company does business. In the very cold winter weather when loading cars with coke coming directly from the make the steam becomes very thick at times, interfering somewhat with the operation of the machine. Also, on the other extreme, when loading coke during the summer the combined heat of the weather and the coke coming from the make are rather severe on the operator. The item of belt expense on the box car loader is reduced somewhat by the steel flights with which the belt is covered. These take the abrasion caused by the impact with the coke which is necessary to bring it up to the belt speed as it leaves the feeding spout. The tonnage per square foot is approximately 62 per cent. greater than with the belt conveyors, and as the belt is narrower and lighter it is of much less consequence in the tonnage cost. This device on the whole is extremely satisfactory.

There are several good systems available for stocking coke, such as locomotive crane, bridge, conveyor, telpher, and manual railway. Representative pictures of each one of these systems, except the industrial railway, are shown in Figs. 11, 12, and 13. The locomotive crane is especially adapted for small plants where it can do the work of handling coal, coke, and other stock, breeze to the boiler room, filling the purifying boxes, and, in fact, the work of handling any material in bulk that may be necessary. The bridge, where the volume of coke to be handled would justify it, can be worked to nice advantage. The conveyor system is applicable where the De-Brouwer type may be extended from the retort house directly to the storage bunker, or even when running on trestles over the yard storage. The telpher system is typified by Fig. 14, and is advantageous when the layout permits of extreme versatility. In the particular installation it serves a combined gas and electric station, handling all the coal, coke and breeze used or produced at both.

The reason that the old fashioned manual railway was chosen, or rather retained, is that none of the systems mentioned would reduce cost or breakage sufficiently to justify the investment necessary. There is, however, a peculiar local condition not shown on the general layout which put these systems at a handicap. The coke yard is located across a city street from the coke screening tower necessitating considerable travel to reach the stock pile. The simplicity and freedom from repairs and breakdowns and the ability to use unskilled operators combined with a very reasonable handling cost make this system very satisfactory on the small amount of coke put into storage. Incidentally, with the more aggressive and functional sales policy of this company, the amount of coke handled to storage is rapidly decreasing. No doubt many of the systems, such as beforementioned, show excellent economies in the handling of the coke, particularly when installed to take advantage of particular local conditions.

The retail pockets are large and numerous enough to take care of any reasonble demand put upon them for well screened coke to the teams and trucks of the dealers and the gas company at all times. It is not necessary to have the retail pockets contain the equivalent of a maximum day's sales inasmuch as the time of the year when such a maximum is reached is when coke is being taken from stock. The time of the greatest service for the retail pockets is during the months of lighter sales. The maximum day's sale of coke for retail delivery from the coke yard is equal to 300 per cent. of the average daily production for a year.

To further better this service the stock recovery is accomplished by means of wagon loaders. This equipment is fast growing in favor with gas companies for this class of service. It finds application wherever the stocking system does not also serve as the recovery apparatus as well. The two types developd which are most used are the belt and the bucket conveyors. The latter, of which this company owns three, were chosen on account of their high capacities and the ability to load the maximum amount of coke with minimum amount of hand feeding. The use of the hand propelling device enables them to be backed into the stock pile thus loading the trucks or wagons with very little labor. One machine of this type has handled over 150 tons of coke in one day, using three men to feed and to tend it. Under favorable conditions, it will deliver one ton of well screened domestic furnace coke per minute. The machine is equipped with shaking screens and a breeze hopper for receiving breeze and fines, which are hauled away by dump carts. One of these machines has been in use two years and has handled about 20,000 tons of coke with comparatively little expense for repairs and up-keep. The power consumption of a machine of this type will not exceed 0.3 kilowatt-hour per ton of coke handled. The better preparation of the stock coke by means of the shaking screen on this device would have justified the investment alone were there no saving in labor. The handling cost with this machine is only 40 per cent. of hand forking.

The wagon loader as a system of stock recovery has its important advantage in the first cost. For a machine whose principal use in four months of the year, a large investment is not warranted. And to cover the range as a standard device for all sizes of plants, from small to large, it must of necessity be low in price. Either this or some better piece of apparatus is necessary for stock recovery, in all plants which stock coke, as the proper preparation of this fuel by hand forking is not possible.

Fig. 7 is the same machine equipped and using a bagging device.

Fig. 8 is a view of the belted type of wagon loader. The lightness and portability of this outfit and the small breeze conveyor are to be noted .

Fig. 9 is a view of two of the wagon loaders used by this company.

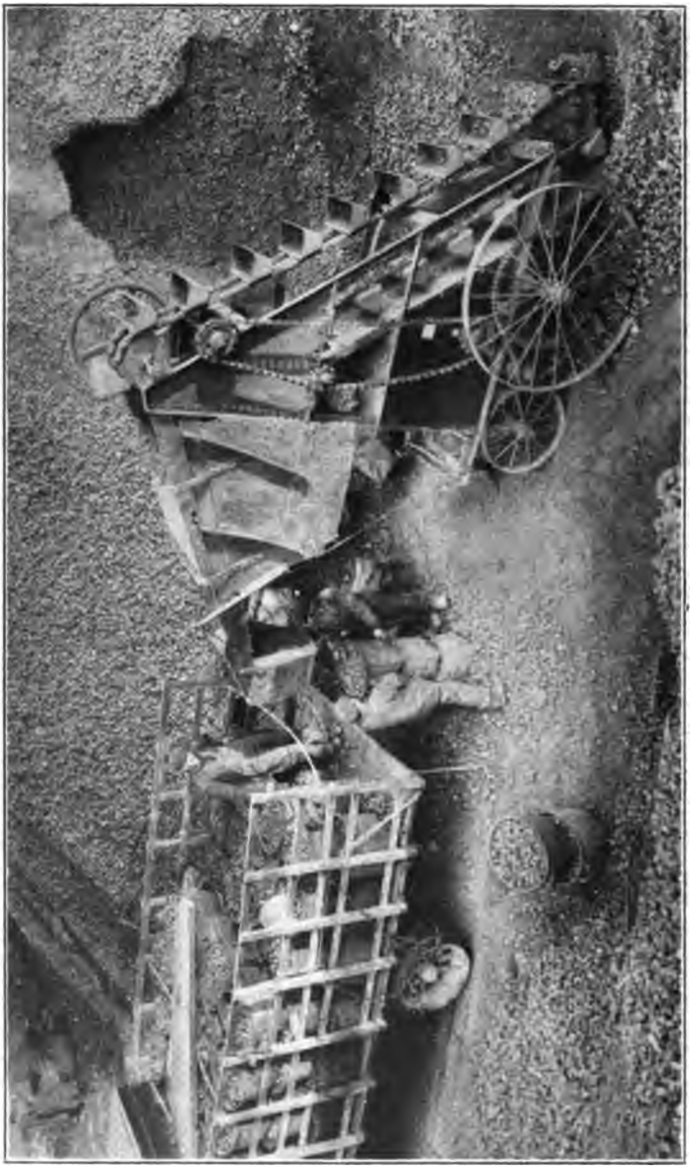


FIG. 7.

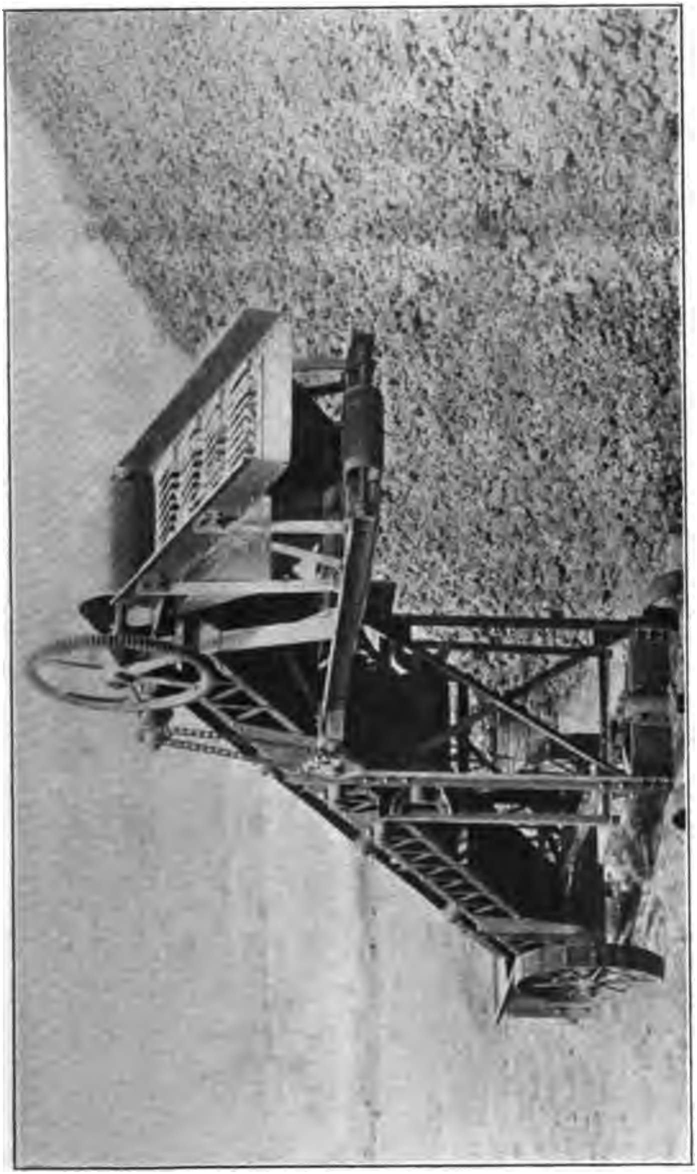


FIG. 8.

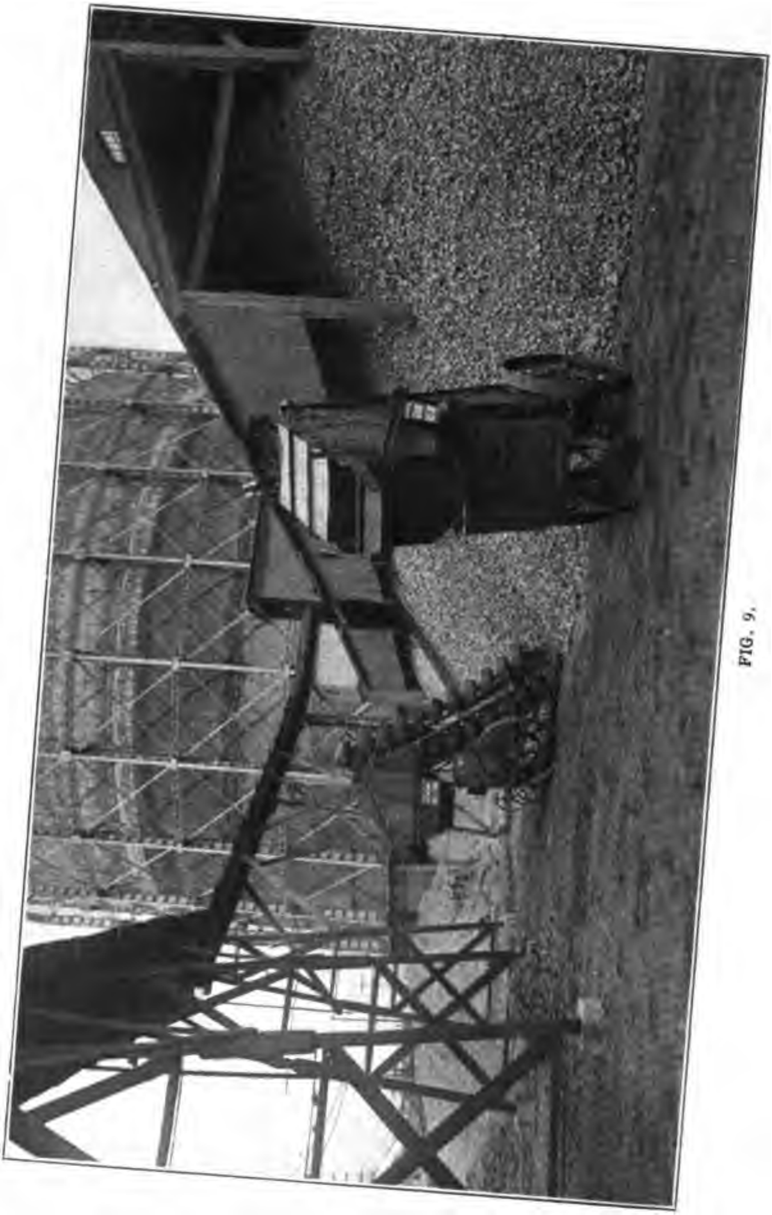
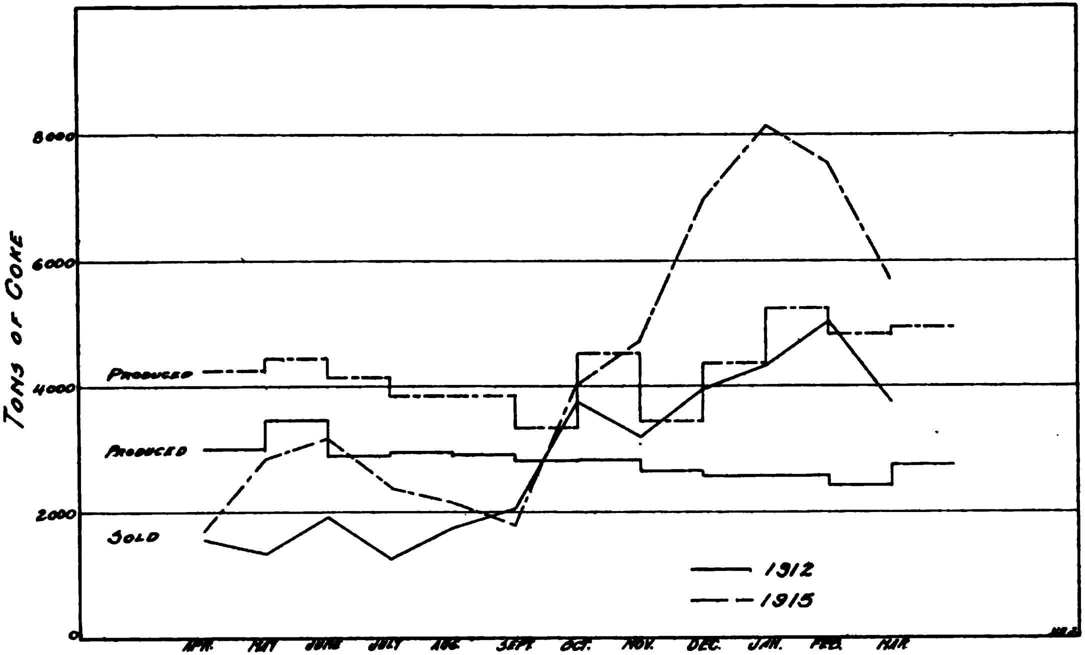


FIG. 9.



COKE SOLD AND PRODUCED BY MONTHS

FIG. 10.

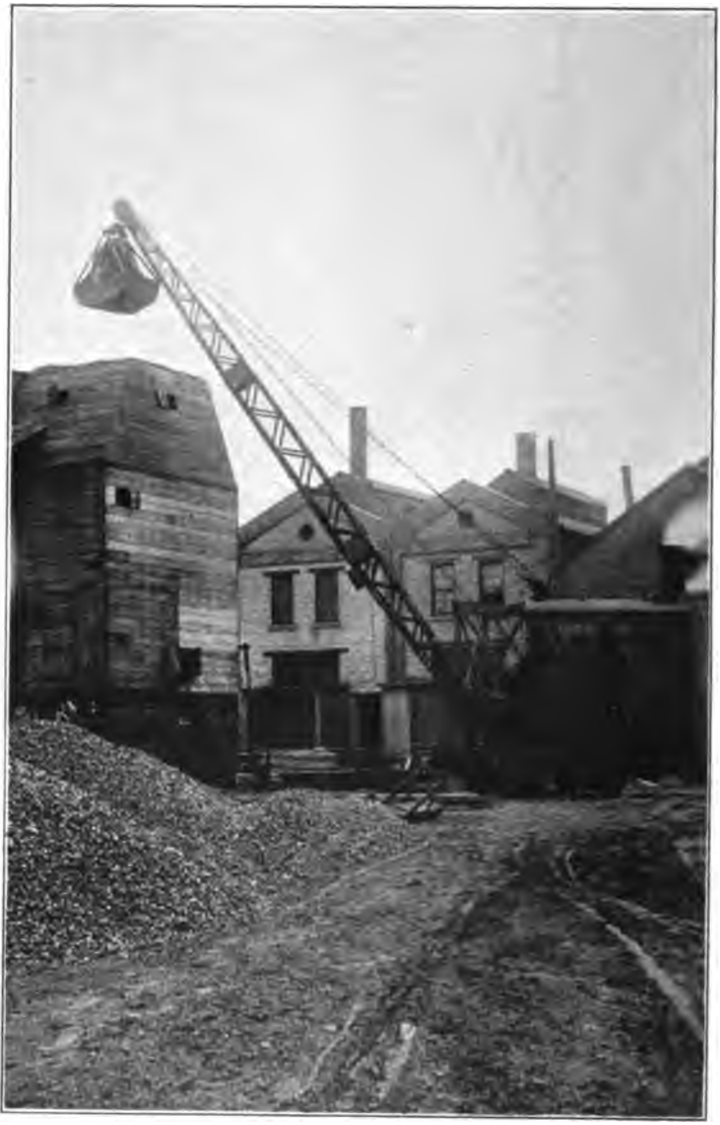


FIG. 11.

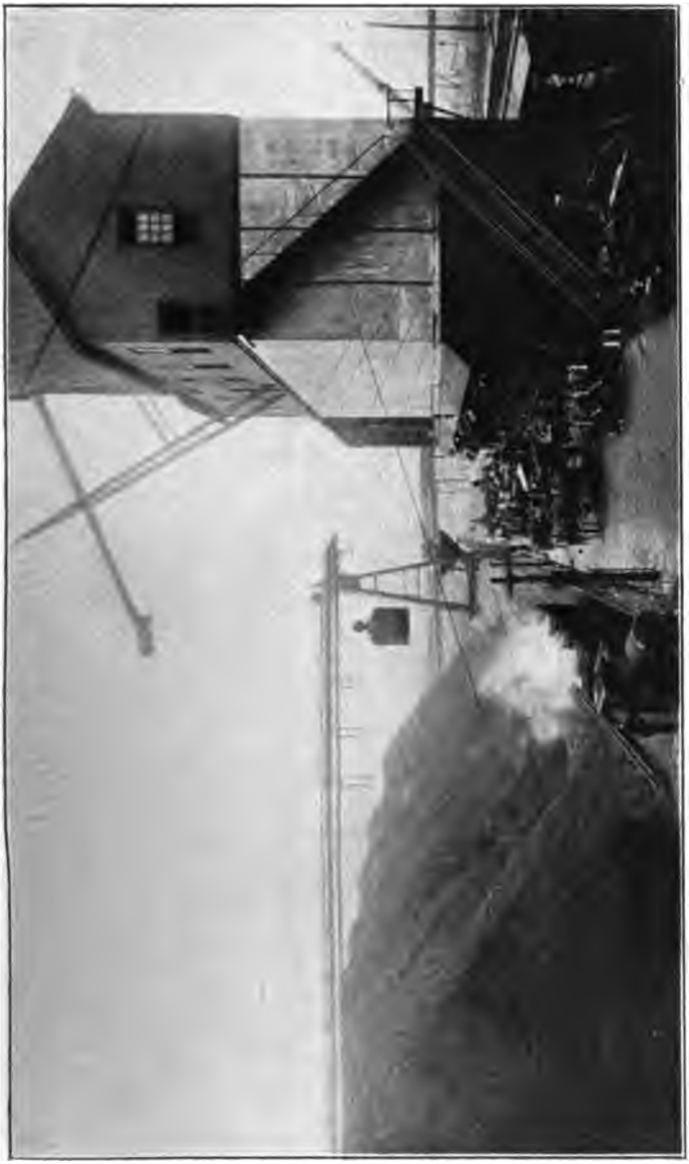


FIG. 12.

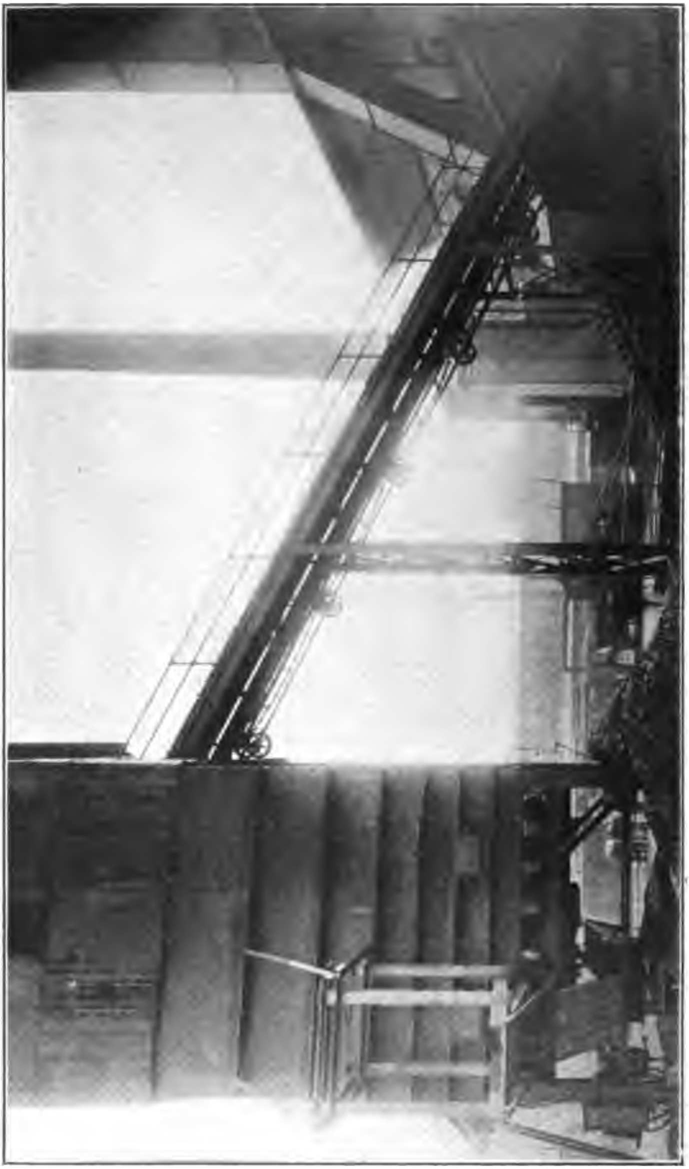


FIG. 13.

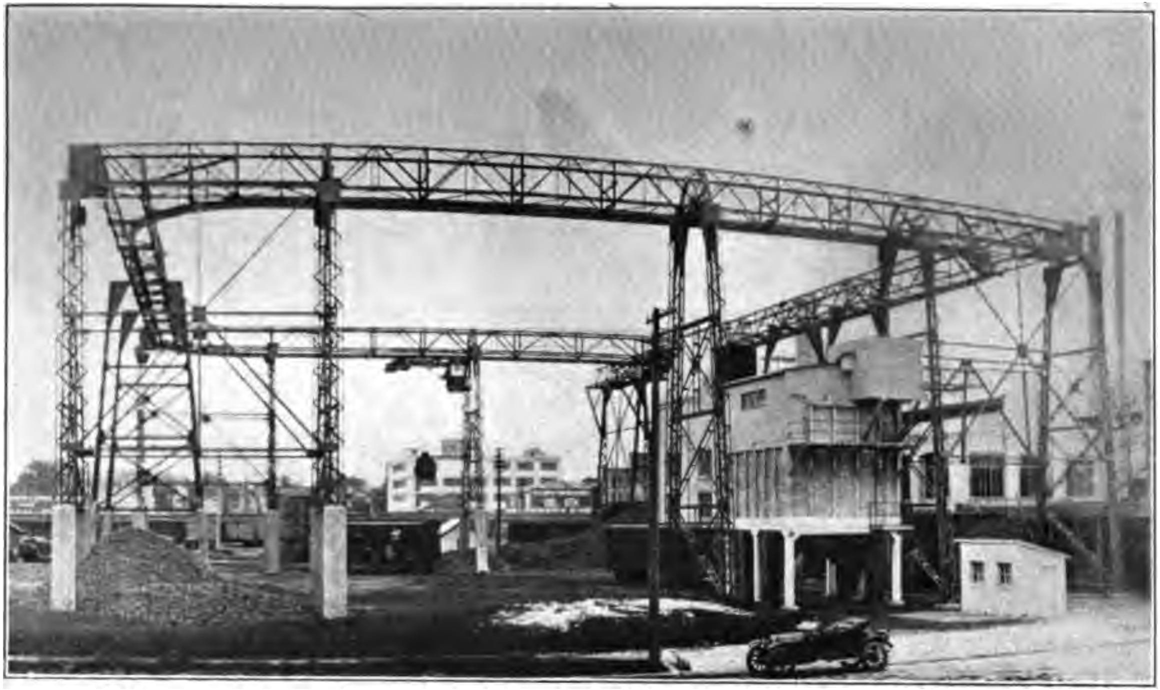


FIG. 14.

This company like most other gas enterprises finds its coke market very nearly 100 per cent. in the domestic field for house heating. The lack of metal industries which use coke as a raw material or for fuel, in the territory served, is the principal cause. It is with extreme difficulty that horizontal retort coke can be produced in the right quantities or of a quality to meet the specifications imposed by this class of trade. This imposes some hardships, inasmuch as in this climate there is no coke consumed for domestic purposes during four months of the year, with considerably more than half of the coke burned during the winter months of December, January, and February. This, of course, necessitates stocking coke inasmuch as the production must continue in proportion to the gas send out. Fig. 10 shows the production and sales curves for 1912 and 1915, the intervening years being left out for clearness. The enormous peak in 1915 during the winter months emphasizes very clearly the sales policies necessary to overcome some of the natural disadvantages of the coke business. The price is reduced 50 cents per ton in May and orders taken from dealers for as much coke as they can store at the reduced price. This enables the company to move considerable coke during the summer months, when there is absolutely no demand for this product, by utilizing the dealers' storage space. On account of this reduction in price a very large percentage of coke users have their bins filled in the summer. To indirectly help this summer buying it is worth some effort to remind architects to put in ample fuel bins in houses they are designing. It is interesting to note that the effort applied to the question of summer sale will show that in 1916 the sales curve for the summer months will be but very little under the production line. This means that the stock will be much decreased, from 25.5 per cent. in 1915 to an estimated 13 per cent. in the late fall. This can be estimated as the summer orders are all taken in May.

In this company the sale of coke has reached such a vast importance, as compared with the total business done, that there is virtually a special organization for promoting it. An official of the company devotes much time to the handling of the business with the dealers and there is constantly kept one representative, whose duties, during the coke season, are to attend to and adjust coke complaints, suggest betterment of service, etc. Retail orders are handled through the Order Department in common with all the other business of that department. They are then sent to the Delivery Department at the "Works," whose duty is to give the very best of service to both consumers and dealers. Orders are delivered exactly when promised, and it is attempted to have all drivers and teamsters educated against the driving over lawns and walks. They are also instructed to use great care to avoid breaking windows and damaging property in any way, or allowing dust to get through the customer's house. Further, and of great importance, lest the whole delivery should suffer by the appearance of a small amount of breeze, all coke is forked off the wagon and what little breeze results from this handling is piled neatly in a pile. Drivers are held accountable for the quality of the fuel delivered inasmuch as they load their own wagons.

One of the most obnoxious questions of the coke business is the moisture content of the product. This is made the target for criticisms by those not wishing you well, and the object of jokes by your friends. Besides the aid given to the elimination of this vexatious feature by the use of the DeBrouwer system, described before, there are additional measures taken. Every car of coke loaded is carefully measured so that the volume contained in the load may be determined. After this is calculated, the equivalent weight of commercially dry fuel is found by multiplying the cubical content by 28 pounds, the weight of a cubic foot of furnace coke. If the net weight shown by the scale does not check this within reasonable limits the explanation is sought and found. This is for the purpose of avoiding mistakes in weighing, and checking any bad digression in the operation of the plant and the preparation of the product. It is also done for the express purpose of making proper allowance in case of excess. The factor, which has been referred to as 28 pounds, is checked up periodically and when conditions require it changed it is done. To so further regulate this variable, samples are taken from time to time on cars and the moisture content determined and recorded. In the coke delivered to the vehicles at the retail pockets, which comprises about 60 per cent. of the total business, the weighers are familiar with the cubical content of most of the wagons and trucks coming into the yard regularly. This serves as a guide and when using proper discretion in weighing exposes any weight variation and automatically checks the weighing.

It is not here meant to be inferred that selling coke by volume is the correct basis for sale. On the contrary, repeated tests have shown that with furnace coke, which is everything resulting from run of make passing over a 1½ inch square mesh screen, this portion comprising 88 per cent. of the total business, variation in casual samples from the same pile, due to variables other than water content, caused a much wider variation in the weight of a cubic foot of the aggregate than is possible to encounter due to water; in other words, samples of coke with the same water content have shown variation in weight per cubic foot of as much as 8 pounds. Whereas with the worst possible condition of water to be encountered, this variation cannot be possible. The same variation due to water would mean more than 25 per cent., and if such coke were offered for sale the seller would very shortly have no customers.

The moisture question has been made subject to regulation by some municipal and state authorities. The local situation is that the city sealer, backed by the local council, has decreed that all fuels sold, if by weight, shall have the moisture allowance above the net wagon weight shown clearly on the weight slip. The weight of this allowance is placed at the discretion of the seller up to a maximum of 6 per cent. This percentage is the arbitrary figure assigned which represents, in the minds of the local authorities, the greatest excess amount fuel carries under local conditions. This excess is not added to laboratory dried or anhydrous fuel but to commercially dry, which means, for gas coke, the amount it will carry when properly stored, which is approximately 6 per cent., making a total allowable moisture content of 12 per cent. This has worked out to the best possible satisfaction, as it creates the minimum of interference by the authorities, and all fuel is subject to weighing and testing at any time, and the customer in all cases knows exactly how much weight he has received and what proportion of it is represented by excess moisture. If a customer is dissatisfied with the weight so shown, he may seek the city sealer for redress. Under the operation of this plant, however, there have been practically no such cases.

There is considerable to be said for and against the use of trucks for the retail delivery of coke. Unless the class of business has a very large percentage of long hauls the truck is very hard to make pay. This company has no trucks, as repeated trials have demonstrated that, under the local conditions to be served, the horse drawn vehicle is cheaper and a little more reliable. The last word is used advisedly and means specifically that in the worst winter weather, when the delivery service is most needed, the truck may be unable to render it. Aside from this, however, and in general, the problem is one of local conditions. Any company located in a city where there is a large percentage of long trips over good paving and some trade which can be served by a dumping truck can do doubt make a truck prove profitable.

In the coke business it is a choice of policy as to the method of selling. Either part or all may be retailed direct to the consumer by the gas company, or it may be sold either part, or in whole, through dealers, giving them a wholesale rate. With this company, about 70 per cent. of the coke sold is through dealers. The reasons for this are logical.

The retailing of fuel is a business, which is subject to the same fundamental principles as merchandising in all branches of business. Those in possession of the avenues of distribution will keep their market unless dislodged by the expenditure of large sums of money for sales and advertising work. The fuel dealers have their market by prior possession and experience. They are highly specialized and, in many cases have minimized the overhead cost by handling other lines which sell during the summer months, such as, grain, ice, and building materials. Obviously it is out of the question for a public service corporation to enter into these pursuits.

Though it may be good business to sell coke through retail dealers, it may not be good policy to put the entire disposal of such a large branch of your business in some one else's hands. If left entirely alone in the field, the dealers would sell the fuel yielding the largest profits, regardless of what it was. Their interest is not so direct as the company's in keeping up the volume of sales of the one product. With the small amount of competition furnished by some retail sales by the producing company, a stimulus is put on the coke sales. Further, the company should have some retail sales for the purpose of furnishing revenue for advertising. It would seem too, that advertising of coke, by any other than the gas company, would take considerable of the punch away from it. In most cases a gas company has a good credit system available, as well as an experienced sales organization which can be used for some direct sales at a minimum of cost.

If the operating department of the company were always 100 per cent. efficient, there would be no coke complaints. But, being human, complaints do enter into the fuel business, and require looking after and adjustment. Sometimes they are unjust and unreasonable, but by far the majority of cases are in good faith. In any circumstances, a policy of fairness and even liberality is accompanied by the cementing of good will with the customers. The exchange of a few tons of fuel each year has been found to be very profitable and for the good of the business. The "customer is always right" is a stellar motto for the coke department of a gas company, and one which this company is endeavoring to live up to.

Coke is advertised in the many ways which all successful commodities are. The words "Genuine Gas Coke" are displayed and advertised so much that everyone knows them. All trucks and wagons are properly placarded with such signs.

Gas bill riders are often used and street car cards and periodical inserts have had good effect. The newspapers are one of the best forms of publicity. A coupon campaign was very effective while sales were lagging. A printed coupon appearing in the daily papers entitled every old consumer of coke to a 50 cent reduction for himself and a new customer whose order for a ton of coke he would bring in to the company's office. This has been used with modification at other plants. The new business department, by the use of representatives who not only sell but demonstrate and follow up till the customer is thoroughly taught in the use of coke, is the most effective of all.

The experience of this company is that to sell its coke, the brand of service is the greatest contributing influence. This covers the entire field and is the alpha and omega. The fuel must be good to start with in structure, analysis, appearance, and preparation. If shipped in cars it should be shipped exactly when promised and represent the best effort of the operating department. Yard equipment must be ample to load rigs, at all times, expeditely and with the best quality of coke. A spirit of co-operation is necessary between all departments concerned with coke marketing and production. Dealers and customers must be treated courteously at all times. Finally, the service of price is to be considered. The ultimate consumer must get the maximum number of heat units in his fuel bin per dollar of cost, convenience and cleanliness considered.

THE CHAIRMAN: The paper is open for discussion.

MR. N. W. GIFFORD (East Boston, Mass.): I should like to ask the author what his standard of moisture is. I would like to ask what success he had with his quenching tower, and whether his deliveries are practically made in bulk or bag.

MR. J. H. TAUSSIG: I should like to know whether he has any trouble with fires in his quenching tower.

MR. H. K. MORRISON: Mr. Chairman, this paper is indeed very interesting, it is a description of a St. Louis coke handling plant. Never having seen it, and not knowing the local conditions, I am unable to say much about it. But the "proof of the pudding is in the eating," and the plant is working well in every respect.

I notice they found difficulty in shaking screens in high buildings on account of the vibrations which were produced. We have in Lynn a set of bins constructed entirely of reinforced concrete with a shaking screen on top, where the vibration is scarcely noticeable.

Fig. 7 on page 174 shows a fair picture, representative of how we handle coke in Lynn. Last winter we were loading into baskets and putting them on trucks.

THE CHAIRMAN: Is there any further discussion?

MR. J. A. PERRY (Philadelphia): All experienced coke men agree that careful sizing and freedom from breeze and dirt are necessary to hold the trade and to secure good prices. Twenty-five cents extra return per ton of coke, due to careful sizing, on a carbonizing plant of 100 tons coal per day and making 51 tons of lump coke for sale per day, gives an increased return of $4,654 per year. This increased return with interest, taxes and depreciation at 15 per cent., justifies an investment of $31,000 for screening apparatus and storage bins.

Excess moisture in coke stored in the open and retained in the winter is the cause of serious complaint where coke is sold by weight. An extra 25 cents per ton, due to low and uniform moisture content would justify $31,000 investment for storage sheds for a plant carbonizing 100 tons of coal per day. This should be sufficient to provide covered storage for 6,000 tons with belt conveyor for filling.

Dealers in the past have been reluctant to store in the summer time even with concessions in prices, owing to shrinkage due to breeze, excess moisture, and so forth. The production of carefully sized coke, free from breeze and dirt, and free from excessive moisture, makes the dealers more willing to stock up than formerly.

It has been suggested that a gas company have its own large special railroad cars for transferring coke from its works to dealers' yards, so as to keep down the average cost per ton so transferred. These cars could be fitted with closed tops to keep out the rain, and be arranged to dump from the bottom. Mr. Shaeffer's paper, read at the A. G. I. Meeting at Richmond in 1913, gives interesting facts and data showing that coke must be quite free from moisture to prevent a large amount of breeze from clinging to the coke until delivered. He showed (p. 420, 1913 PROCEEDINGS) that increasing the moisture in egg coke from 3.1 to 8.2 per cent., increased the percentage of breeze clinging from 1.08 to 7.8 per cent. In the range size of coke, increasing the moisture from 6.1 to 8.1 per cent. increased the breeze clinging from 2 to 7.35 per cent. In the chestnut size, increasing the moisture from 8.3 to 10 per cent. increased the breeze clinging from 3 to 8.65 per cent. In the pea size, increasing the moisture content from 9.2 to 10.1 per cent. increased the percentage of breeze clinging from 5.4 to 11.5 per cent.

Drying in transit or in cellars of coke containing excess moisture is bound to show not only shrinkage in weight, but an excessive amount of dirt and breeze that has been clinging to the coke. This is sure to cause unfavorable impressions and complaints of quality, and so forth, resulting in dissatisfied consumers and falling off of repeat orders. It will eventually pay to re-dry and re-screen the smaller sizes of coke to save freight, to reduce complaints, and so forth, since in the long run the customer is not going to pay for water and breeze.

MR. TAUSSIG: I have often heard of the high expense and the upkeep of the De Brouwer conveyors.

If Mr. Seymour has any figures on that upkeep, I should like to hear about that from him.

MR. J. P. HAFTENKAMP (Rochester): I was in hopes that Mr. Seymour would tell us how his company handles the coke business from the plant to the consumer. I am anxious to know whether it is handled in paper or canvas bags; the number of sizes of coke which are handled; the percentage of moisture allowed, and whether this is determined by State or city ordinance, and what the relation of the percentage of moisture is in coke which is stored out of doors and that which is stored under cover.

Mr. A. S. B. Little (Springfield, Ill.): I notice on pages 164 and 165, it is stated: "The rotary screen which is so much used for anthracite coal, sizing and for by-product coke preparation was found entirely too rough on horizontal retort coke which is produced at this plant.

I would like to ask where it was found that that type of screen was not proper for sizing coke from a horizontal retort? My experience is that the only practical way to size gas works coke is to use a rotary screen with wire meshes.

Mr. A. H. Harris, Jr. (Joliet, Ill.): (Written discussion communicated.) After having had experience with both an intermittent vertical retort plant and a by-product coke oven plant, it seems that great improvement could be made in the handling and quenching of hot coke from gas retorts if some of the methods used in handling by-product coke were incorporated into retort house practice. The DeBrouwer conveyor is at its best very severe on the coke, and the sooner we abandon this device as a means of quenching cars such as are used in coke plants and inclined oven plants, the better will be the results obtained, in both the quality of the coke as regards its appearance, moisture content, and decreased quantity of breeze and small coke. Of course this will require some decided changes both in the design and operation of retort houses, and probably for small plants would not be practical, but it is a subject that should be very carefully looked into by engineers and designers. A large step forward has been made in the moving of the coke from the retort house before the final quenching, and a greater improvement would be in distributing this coke upon a wharf in such a manner that it will be spread in a fairly even layer and allowed to dry and cool before being sent to the screening plant, or to stock. Such ideas when carried out in by-product oven operation produce a coke that contains less than 1 per cent. of moisture for the foundry or large size coke, and under 4 per cent. for run-of-oven coke, usually running between 2 and 3 per cent.

Belt conveyors are the ideal transporting mediums for coke, and whenever these can be used a great saving in expense and breakage is obtained. The belt conveyor is not necessarily a straight line proposition, as we have two belts on our plant carrying their load in a horizontal position over a length of 50 to 140 feet and then assuming an inclined position of about 15°. Of course the belt cannot be stretched too tight or it will rise off the idlers at the curved section. We also have a belt running at an inclination of 22°. We have found that rubber covered belts are much superior to a straight canvas belt due to the fact that a canvas belt will change its length with every change of moisture in the coke it carries, and to a great extent in the atmosphere. We have tried several makes of canvas belts which were guaranteed not to do this, but none of them stood up in practice. In regard to box car loaders we have discontinued the use of steel flights attached to the belts as they caused considerable breakage to the coke, particularly foundry size. Foundry coke is separated from the run-of-oven by being passed over revolving disk grizzleys, and the coke as separated is fed to the loader so slowly that the steel flights hit each piece, causing considerable breakage. In loading domestic coke we find that by feeding the coke to the loader in as large a quantity as it will take there is practically no breakage, and the wear on the belt amounts to very little. We load from 12,000 to 15,000 tons with one domestic car loader belt against 3,000 tons with the foundry car loader belt, before having to change them.

Any system where dry coke may be stocked and all of it reclaimed without having to use hand labor should prove an economical one; particular emphasis should be laid on the statement of dry coke being put into stock. If this can be done you will be able to take dry coke out of stock, without the expenditure for a storage shed. If coke is put into stock wet it never gets a chance to dry out, except the very outside layer, and if more wet coke is continually being put into the pile the case is hopeless. Dry coke, when once it is cool, will absorb very little water, and moisture from rains penetrate but a short distance into the pile, and is practically dried out on the first sunny day. We were able to prove this last summer when the small screened dry coke, stove and nut, for which we had no sale was stocked during the summer months. When we reclaimed our stock pile in the winter this coke was recovered in its same dry condition, whereas, our run-of-oven coke which had been put in stock with an excess of moisture so as to prevent the possibilities of fire, was just as wet as when it went in, and during the extreme cold weather was frozen into one solid mass. We have taken precautions now to see that any coke put into stock is as dry as that which is sold.

THE CHAIRMAN: Mr. Seymour, will you please conclude the discussion.

MR. F. W. SEYMOUR (Grand Rapids, Mich.): First I will answer the question as to the standard of moisture. As explained in the paper, in our community the City Sealer has declared that domestic furnace size coke, which is that going over a 1½-inch square mesh screen, shall not contain more than 6 per cent. excess moisture. He has arrived at that figure by taking samples systematically and periodically from coke both under outside storage and otherwise.

We found by repeated tests that our coke in storage came to equilibrium at about 6 per cent. moisture which is commercially dry coke. The excess moisture then to be added to this makes it compulsory to allow 6 per cent. in weight up to a total content of 12 per cent. which is the extreme under which coke can be dealt in and delivered. This may sometimes be exceeded by some of the smaller dealers, but in our case where coke is stocked high in storage, to exceed 30 feet in height, we cannot find any great difference between that contained in storage and that which is outside. Hence the statement in the paper that housed storage does not pay.

Most of our business is handled in bulk. We have sought to discourage bagging on account of expense and inconvenience.

As to fires in the quenching or cooling bunker, we have had that experience a few times, but have found with the plant running in normal operation there are no fires. Bad conditions of operation in the retort house cause them and the only cure for them is to go back to that equipment and have more rigid standards of operation.

The statement is made in the paper that the maintenance of the DeBrouwer conveyors is high. We have not been operating long enough to determine whether this feature will be justified with comparison to the other systems.

One gentleman wanted me to go more into the market end of it. Our market is 98 per cent. in the domestic field due largely to the desirability of it. We have been unable to compete successfully in the industrial or the metallurgical and blast furnace fields. Further than that the sales policies are explained in the paper.

My authority for stating the unsuitability of the rotary screen for retort coke was questioned. That statement is based on the experience of a large plant which has used this device for several years on horizontal retort house coke.

THE CHAIRMAN: I wish to thank Mr. Seymour for his very interesting paper. I saw the Chairman of the Nominating Committee come in just now. Are you ready to report, Mr. Chairman?

MR. R. B. BROWN: The Nominating Committee begs to submit the following nominations for Vice-President of the Manufacturing Section, one of these names to be selected by the General Nominating Committee at the next annual meeting: J. H. Taussig, A. B. Macbeth, Donald MacArthur.

THE CHAIRMAN: It is moved, seconded and carried that the report be accepted, the nominations closed, and that the Secretary cast one ballot for the Section.

You have heard the motion. All in favor say aye; opposed, no. It is carried. The Secretary informs me that he has cast one ballot, for the ticket as named.

The next is the report of the Committee on Refractory Materials, of which Committee Mr. J. W. Batten is Chairman. Mr. Batten will present the report.

REPORT OF COMMITTEE ON REFRACTORY MATERIALS.

The third year of the existence of the Refractory Materials Committee sees the development and, to some extent, the accomplishment of the aims and purposes of this Committee, as set forth by its Chairman, Mr. Herman Russell, in the first report to this Institute in 1914.

Very satisfactory progress has been made in the determination of the conditions which refractory materials must meet in practice, particularly with respect to those refractories met with in coal gas installations, and close approximations have been made regarding the qualities which such material must possess, in order to best meet those conditions. Determination of reliable and practical methods of making the desired tests has been undertaken by the Bureau of Standards. This work, it is confidently expected, will be concluded during the coming year.

The meetings held during the year have been joint sessions with the members of the Gas Refractories Committee of the Refractories Manufacturers Association, whose co-operation has made possible whatever development has occurred.

Without a laboratory, adequately equipped, and properly supervised and directed, no intelligent results could have been arrived at. Both of these continue to be admirably supplied by the Bureau of Standards at Pittsburg, under the direction of Prof. A. V. Bleininger.

The first meeting of the year, held at Rochester, N. Y., was largely concerned with the discussion of the final draft of specifications for coal gas materials, both clay and silica. This went forward to and was approved by the Refractories Manufacturers Association at their Pittsburg meeting. The meeting of the joint committees, which immediately followed the above-mentioned meeting, discussed and determined upon prosecution of certain other work, a large proportion of which was again undertaken by the Bureau of Standards, and the remainder by certain sub-committees.

Specifically, the following matters were dealt with:

(1) It was pointed out that two 9-inch bricks placed side by side, with a joint, made more than 9 inches. It appeared desirable to change this condition, so that two bricks placed side by side with a joint will make up 9, and the Refractories Manufacturers, through their Committee, will be asked if they are agreeable to such a change.

(2) At the suggestion of the Refractories Manufacturers Association, the Bureau of Standards has been requested to further continue some experiments looking to the development of a high clay brick possessing the characteristic of ability to withstand considerable load at temperatures up to 1,425° C. with only slight contraction.

(3) Characteristic samples of bricks, available in various sections of the country, have been sent to the Bureau of Standards at Pittsburgh, where the characteristic expansion curve and thermal set of each will be determined. By this means it is hoped to be able to assist in making the proper selection of materials for various purposes.

(4) An attempt will also be made to substitute for the elaborate and difficult "pier" test, some easily made test such as the above giving comparable results.

(5) A sub-committee, under the direction of Mr. J. H. Taussig, is now working on a draft of a specification for water-gas checkerbrick, which later will be elaborated to include linings as well.

(6) A further sub-committee, Mr. H. L. Underhill as Chairman, has under investigation the subject of Refractory Cements, determining the various functions which they must perform and gathering whatever data or experience is available.

Your Committee feels that the work outlined for next year will be of decided value and recommends its continuance.

Respectfully yours,

J. W. BATTEN, *Chairman*,
W. H. BLAUVELT,
J. S. DEHART,
W. H. FULWEILER,
J. P. KENNEDY,
HERMAN RUSSELL,
A. E. SMYSER,
J. H. TAUSSIG,
H. L. UNDERHILL.

THE CHAIRMAN: The report of the Committee on Refractory Materials is now open for discussion.

MR. F. W. SEYMOUR: I have read the report of this Committee with a great deal of interest, and your Committee is certainly entitled to the thanks of the Institute for the hard work and the clever way in which they have handled the subject.

One point I would invite attention to is that we are all quite certain there have been some failures of refractories through poor work in erection. The workman is not under the bond which the bench contractor is, as he is here to-day and away to-morrow. Some of you may have seen such cases where fire-brick was laid with mortar joints so thick that you could stick your thumb between the bricks.

Also what standard are you to apply as to the uniformity of brick or tile and how much variation allowed in length, width, and thickness, and if warped, how badly should they be so before being rejected? Also how large joints should be allowed and how many courses per unit of height? In other words, would it not be a point of value, especially to the smaller works, if a code of workmanship were appended to the chemical and thermal specifications for the factory?

MR. J. P. KENNEDY: Page 2 of the report, Specification 5, the Sub-Committee, under the direction of Mr. J. H. Taussig, is now working on a draft of a specification for water checkerbrick, which later will be elaborated to include linings as well. I would like to ask, does the Sub-Committee wish to prescribe tests for the specifications which they present?

MR. J. H. TAUSSIG: We have standardized a test on checkerbrick which has proven very successful. I believe the Peoples Gas Light & Coke Company of Chicago has a similar test. The relative merits of brick for checkerbrick work are shown very plainly in our test. This coming year we expect to make specifications for these tests and also for material for lining water gas shells.

THE CHAIRMAN: Is there any further discussion?

MR. HERMAN RUSSELL (Rochester, N. Y.): The specifications prepared last year take care of the feature of warpage, and this was discussed at great length in the Committee.

THE CHAIRMAN: Mr. Batten, will you please close the discussion?

MR. J. W. BATTEN: I believe the questions have been fairly well answered, Mr. Chairman, particularly those asked by Mr. Seymour in relation to warping of tiles. As Mr. Russell has indicated, this information was given in the report last year. In regard to the water gas checkerbrick, it is hoped satisfactory specifications can be worked out which will be in a respect similar, as far as form goes, to the specifications already submitted for coal gas materials.

THE CHAIRMAN: Will some one move the acceptance and adoption of the report?

(Moved and carried.)

THE CHAIRMAN: The next paper is Mr. F. L. Weisser's paper, "Oils for Water Gas."

(Mr. F. L. Weisser, San Antonio, Tex., presented his paper "Oils for Water Gas.")

OILS FOR WATER GAS.

Years ago, before the gas industry had assumed anything like its present proportions, the manufacture of water gas was somewhat of a rule-of-thumb procedure. About 4 or 5 gallons of oil was customarily prescribed and few gas engineers knew much about the quality of the oil or the effect of quality on the results.

Good gas oils could be secured in years gone by without great difficulty. There was an abundant supply of raw material to select from, the prices were reasonable, and with the development of new oil fields it was not unusual to obtain crude oil direct from the well which was good enriching material for water gas.

Some of the conditions that have hastened the present need of investigations of gas oil, are first of all, the enormous production of gasoline and of lubricating oil which followed the advent of the automobile; secondly, the rapid increase of the gas business; thirdly, the discovery of the southern oil fields some of which produce oil which cannot be used successfully for the enrichment of water gas; and fourthly, the cost of the material now available.

This does not mean that good gas oils are not now obtained, but that some of the oil now offered as gas oil is very unsatisfactory, hence an intelligent understanding as to what constitutes good or bad gas oil becomes imperative.

The troubles encountered with certain grades of gas oil now offered for gas making are entirely beyond the control of the gas maker. The usual indications of bad gas oil are first, a decrease in production, caused by the carbureter beginning to stop up, the temperature as indicated by the pyrometer becomes an unruly element, the formation of naphthalene becomes from three to four times normal, and the operating efficiency of both fuel and oil decreases; in other words there is trouble all around. Still, the tests usually applied to gas oils do not show anything startling. The specific gravity is about right, its color is about the same, its odor perhaps somewhat more pleasant than it used to be, and the distillation tests, with perhaps a little greater per cent. of residue remaining, indicate nothing abnormal.

The source of trouble is often sought in the method of operation, the temperature is changed first one way and then the other way; the amount of air blown through the carbureter is increased until the limit has been reached; a careful analysis is made of the blast gases, samples of which are taken at various parts of the gas machine, also the finished gas is carefully analyzed; a change in the length of time of both the blow and of the run is tried out; and finally when all means and methods have apparently been exhausted we find that nothing definite has been ascertained. The real source of trouble may be ascertained by proper oil tests.

The object of this paper is to indicate as accurately as possible, under approximate operating conditions the characteristics of various grades of gas oil, the composition of which having been determined, with especial reference to the following:

1. The volume of oil gas produced per unit quantity of gas oil.

2. The relation between the amount of asphalt basic oil present and the amount of gas produced.

3. The relation between the amount of naphthalene produced per per cent. of asphalt basic oil present.

4. The relation between the formation of free carbon, when the oil cracks up under various temperatures, to the per cent. of asphalt basic oil present.

5. The relation between the formation of free carbon and various cracking temperatures.

6. The relation between the production of oil gas and various cracking temperatures.

7. The effect of the presence of varying quantities of as-

phalt basic oil present, in the oil when "cracked" under varying temperature conditions, upon the efficiency. That is, the actual number of heat units transmitted from the gas oil to the finished enriched water gas.

8. The effect of varying quantities of asphalt basic oil present on the amount of tar produced, and the amount of hydrocarbons condensing out of the gas when chilled suddenly in a series of coils or tubes submerged in ice.

It is a difficult matter to make these determinations under actual operating conditions and attain anything like a reasonable degree of accuracy. The use of the gas machine is entirely out of the question, for the reason that it would require great quantities of the various oils to be tested which would involve considerable expense, and, furthermore, it would be extremely difficult to obtain with any degree of accuracy the data necessary for the calculation of the results.

The only course remaining is the construction of a miniature gas machine, or cracking apparatus, which can be controlled in principle and in practice similar to the actual water gas generating apparatus. Some of the larger gas companies have used for some time, cracking apparatus consisting of a tube which can be heated to the desired temperature. A sample of the oil is then introduced and determinations are made from the gas produced when the oil has been cracked. Real valuable information has been obtained with this apparatus, by which the gas maker may arrive at a clear idea concerning the quality of the oil he used, and how to use it. Mr. R. C. Downing of Chicago, who has recently written a paper entitled "Some Fundamentals Effecting the Utilization of Gas Oil in Carbureted Water Gas Manufacture," which was read before the Illinois Gas Association gives most excellent information regarding the construction and manipulation of a cracking apparatus designed for laboratory purposes.

The apparatus used in this investigation was patterned after the one mentioned above. It consists of a 2-inch pipe, 42 inches long, capped at both ends. It is surrounded by a layer of fireclay about 1½ inches thick. This tube is suspended within a specially designed furnace having ample space between the fireclay tube and the furnace walls to insure proper circulation of air. The furnace is heated by means of an air-blast gas burner, which is made out of a ¾-inch pipe extending the full length of the fireclay tube, having two rows of 3/32-inch perforations spaced ½ inch apart. The blue gas and gas oil are admitted to the scrubber through a ⅜-inch pipe tapped into the center of the cap at one end of the 2-inch tube. This pipe projects 8 inches into the 2-inch tube. The oil burette connects with the inlet pipe by means of a tee and is supported above by means of a ⅛-inch pipe which also serves as a pressure equalizer. (See diagram of apparatus for cracking tests.) Holes are inserted into the side of the furnace, extending through to the pipe inside the fireclay, through which the thermocouples of a pyrometer are inserted.

Two holders are used for the manipulation of this apparatus, one for the blue gas which connects to the inlet of the carbureter through a meter, and one for the finished gas which is connected at the outlet of the condenser and scrubbers. The tar is collected partly in two seal pots, and partly in the condenser and scrubbers. The cooler, by means of which the gas is cooled to a temperature of about 60° F. consists of a series of U-tubes packed in a box of cracked ice; the condensation is collected in the U-tubes. The meter for the finished gas is installed between the cooler and the finished gas holder. Thermometers are placed to register the temperature of the gas oil as it enters the carbureter, of the gas at the inlet and outlet of the cooler, and of the blue gas and finished gas meters.

The blue gas may be made with a specially constructed blue gas generator. In these tests, however, it was found more convenient to take the blue gas from the generator of the regular water gas set, and the extra laboratory equipment was thus dispensed with.

To perform the test, the temperature of the carbureter is first brought up gradually to the desired value. This should require from 1½ to 2 hours in order to obtain uniform results, a little practice will soon enable the operator to adjust the burner in such a manner as to maintain very uniform temperature conditions. The oil burette, seal pots, condenser bead and cotton scrubbers are set in place while the furnace is heating up, the weight of the latter having been previously

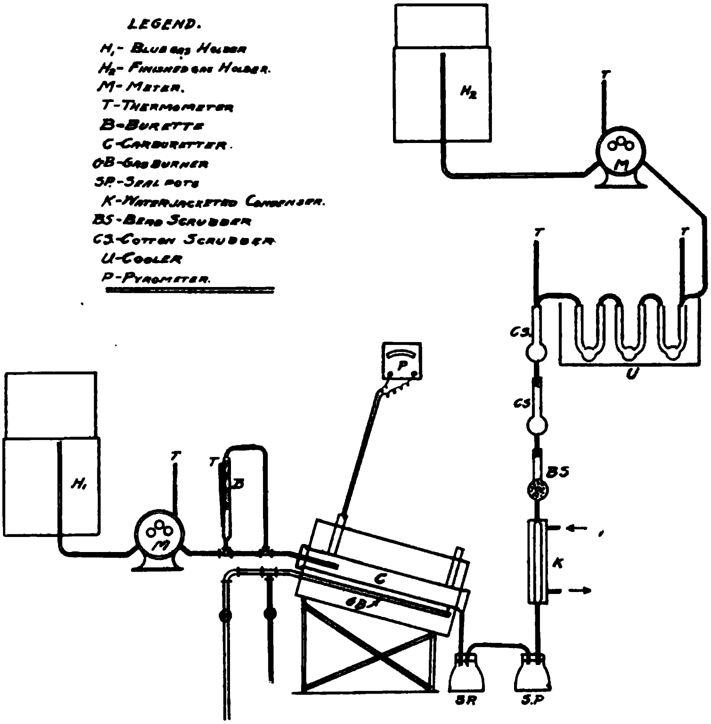


DIAGRAM OF APPARATUS FOR GAS OIL CRACKING TESTS, OILS FOR GAS MAKING.

determined. Thermometers are placed to register the temperature of the gas oil sample in the burette of the gas at the inlet and outlet of the cooler, and of the gas passing through the blue gas and finished gas meters. When the desired temperature has been reached, the entire apparatus is well purged in order to displace all air and examined very closely for leaks. After the initial set of readings of the blue gas meter, finished gas meter, oil burette and pyrometer have been taken the blue gas is passed through the cracking apparatus at the rate of about one-tenth of a cubic foot per minute, and the gas oil is admitted at the rate of about 1½ to 2½ cubic centimeters per minute, depending upon the quality of the gas oil and upon the temperature at which the cracking test is to be performed. Readings are taken of the thermometers as indicated above and of the pyrometer at regular intervals of about two minutes.

When the holder containing the finished gas has been filled, the blue gas and the gas oil is stopped. The seal pots, condenser, bead scrubbers, and cooling tubes are taken down. Care must be taken to avoid the loss of any of the material collected by evaporation, for this reason all the flasks and tubes must be stopped up immediately after having been taken down. After the furnace has been cooled off, the cracking tube is taken down and the tar is thoroughly removed from its connections. Also the tube through which the gas oil is admitted is cleaned, and a corresponding correction is applied to the quantity of gas oil used in case any remains on the inside.

The volume of the blue gas used and of the finished gas made is then obtained from the respective meter readings and is corrected for standard conditions. The following determinations are made:

1. The analysis of the blue gas used.
2. The analysis of the finished gas made.
3. The amount of tar collected.
4. The amount of condensation collected.
5. The amount of oil gas used.
6. The amount of carbon formed.

7. The amount of blue gas used.
8. The amount of finished gas made.
9. The heating value of the blue gas.
10. The heating value of the finished gas.
11. The amount of naphthalene produced.
12. The specific gravity and flash point of the enricher.
13. The per cent. asphalt and paraffine basic oils present in the enricher.
14. A fractional distillation of the enricher.

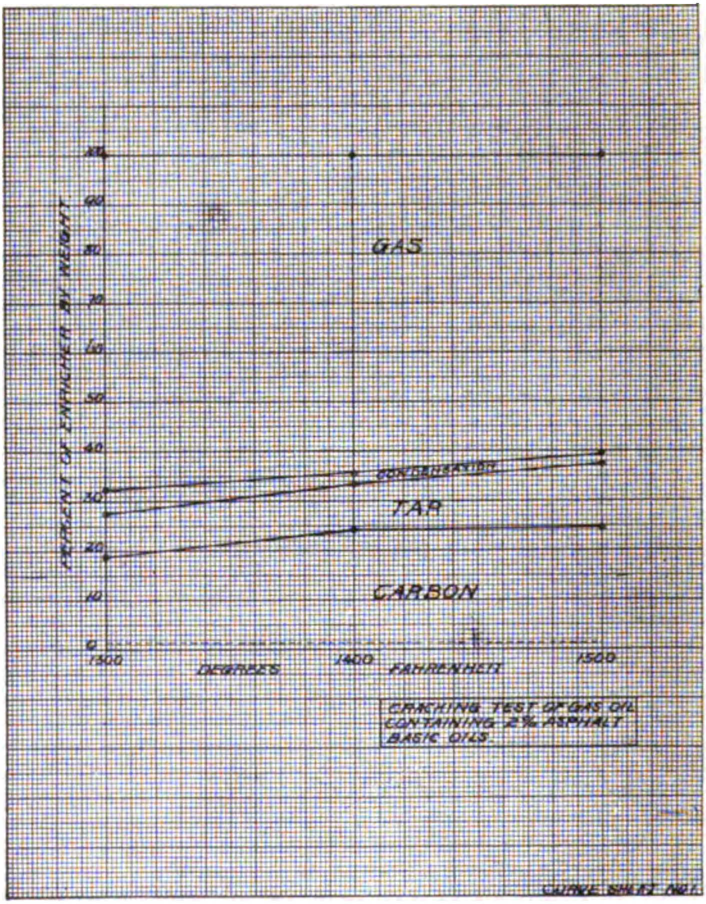
The analysis of the gas was made in the usual manner, that is, the CO_2, O_2, illuminants, and the CO were determined by absorption, the hydrogen and methane by explosion, and the nitrogen by difference. The amount of tar and of condensation collected was determined by direct weight. The weight of the gas oil used, calculated from the volume indicated by the burette readings, was corrected for the difference in specific gravity at 60° F., the temperature to which the specific gravity is referred, and the actual temperature at which the gas oil was used. After having determined the weight of the tar and of the condensation collected, and the total weight of the gas oil used and blue gas used, also the total weight of the finished gas made, the amount of free carbon formed in the cracking tube is determined by difference. The heating value of the finished gas was determined by calorimeter and also by calculation, the heating value of the blue gas was determined by calculation. The amount of naphthalene produced was determined by passing the gas through a 1/20 N solution of picric acid, the volume of picric acid combining with the naphthalene is found by titrating the remaining solution with potassium hydroxide solution, and the weight of naphthalene is calculated therefrom; both solutions are previously standardized. The amount of asphalt and paraffine basic oils present in the gas oil was determined by the acid test. This consists of treating a known quantity of the sample of the oil with an excess of concentrated sulphuric acid, and after having been stirred for about 10 minutes a volume of water is added approximately equal to original sample of oil taken. The mixture is set aside, the asphalt basic oils, being attacked by the sulphuric acid, will form a dark brown precipitate and settle on the bottom, the paraffine series oils being lighter than water will settle on top of the water, the volume of which is read off the graduated cylinder in which the test is performed. This method is based on the fact that all paraffine basic oils will not unite with sulphuric acid and that all asphalt basic oils will unite with the acid. As a matter of fact, however, the paraffine basic oils will be attacked by sulphuric acid but only in a very slight degree if permitted to remain in contact with each other for a sufficient length of time. However, in the absence of a better and more accurate method, the acid test was used. The fractional distillation tests were performed in a standard side neck distilling flask, 100 cubic centimeter samples were used, in cutting off, the vessel containing the fraction was not removed until the mercury had crossed the desired point a number of times, the temperature of the oil was lowered by removing the flame. The specific gravity of the oil was determined by means of a Baumé hydrometer.

A sheet of sample calculations, data and result sheets of each sample of oil cracked up at various temperatures, and of the various samples of gas oil cracked up at the same temperature is shown below.

Curves were plotted showing the following relations:

1. The percentage of enricher producing carbon, tar, condensation and gas and temperature.
2. Cubic feet of oil gas formed per gallon of enricher and per cent. asphalt basic oil present.
3. Per cent. carbon produced per gallon of enricher and per cent. asphalt basic oil present.
4. Per cent. tar produced per gallon of enricher and per cent. asphalt basic oil present.
5. Per cent. condensation formed per gallon enricher and per cent. asphalt basic oil present.
6. Per cent. of total B. t. u.'s per pound of enricher transferred to the finished gas per cubic foot and per cent. of asphalt basic oil present.

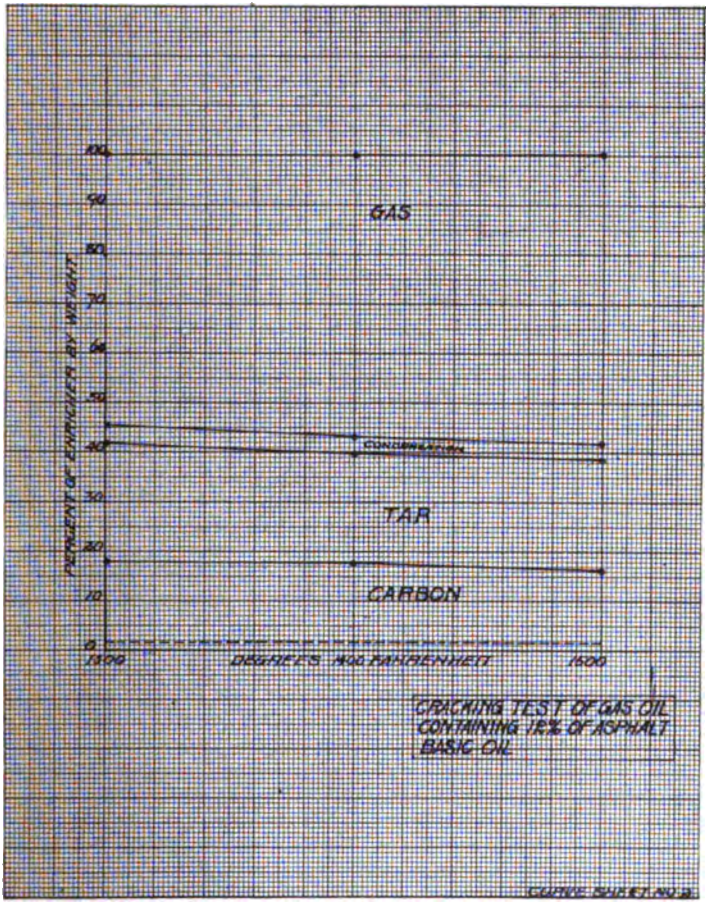
Curve sheets Nos. 1 to 4 show the relation between the various components, into which the gas oil resolves itself, with respect to each other, and also to the temperature at which the reaction takes place. These curves illustrate the relative values of a gas producing material of the various grades of gas oil, and also the effect of the presence of asphalt basic oils.



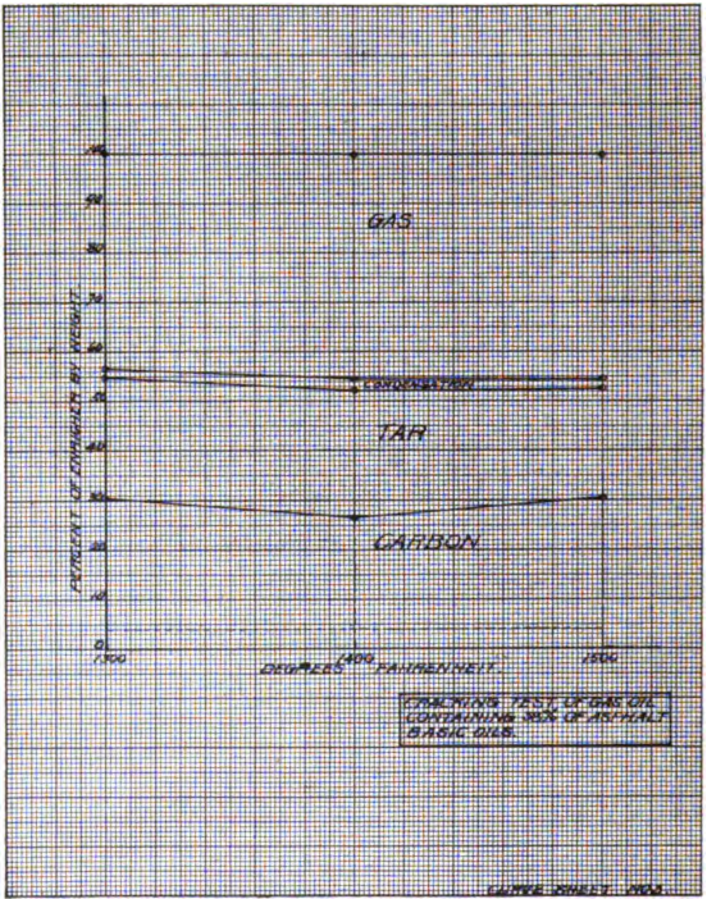
CRACKING TEST OF GAS OIL CONTAINING 2% ASPHALT BASIC OILS

CURVE SHEET NO 1.

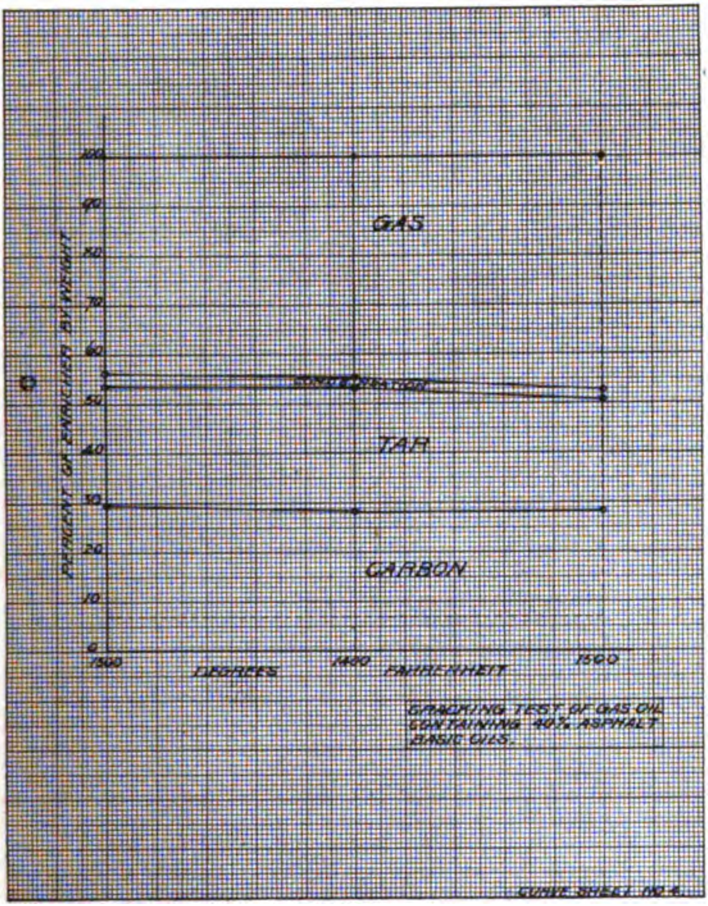
The space between the axis of abscissae and the dotted line drawn parallel to it, represents the per cent. of enricher producing carbon due to the residue in the oil, this quantity is constant for all temperatures. The total space between the axis of abscissae and the second line drawn parallel to it, represents the per cent. of enricher producing carbon at the various temperatures. The space above the carbon represents the



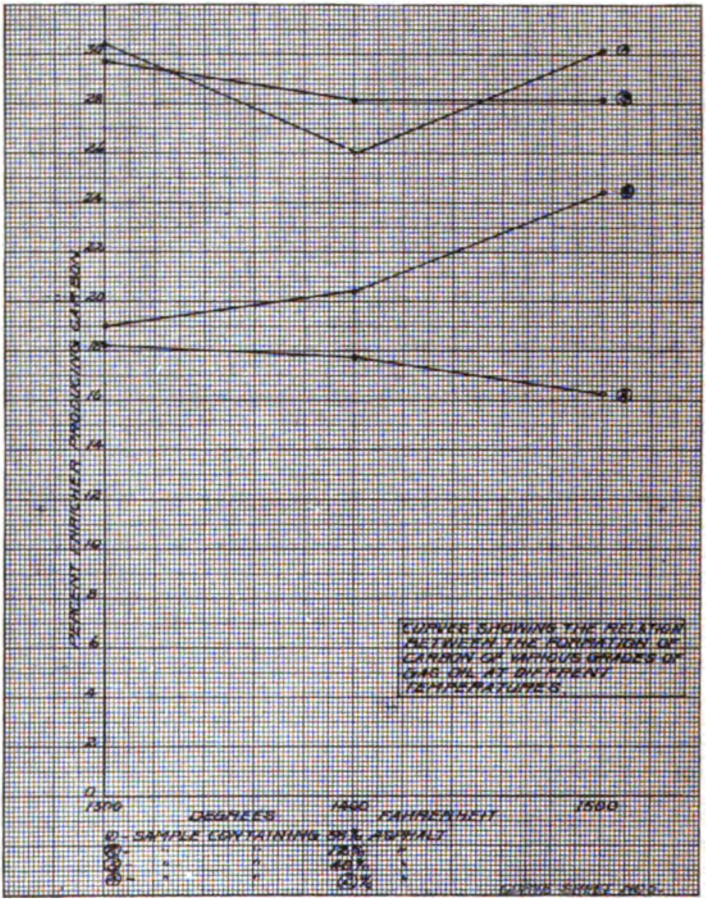
per cent. of enricher producing tar, the next space represents the amount of enricher condensing out of the gas during the cooling process, and the upper space represents the per cent. of enricher producing oil gas.



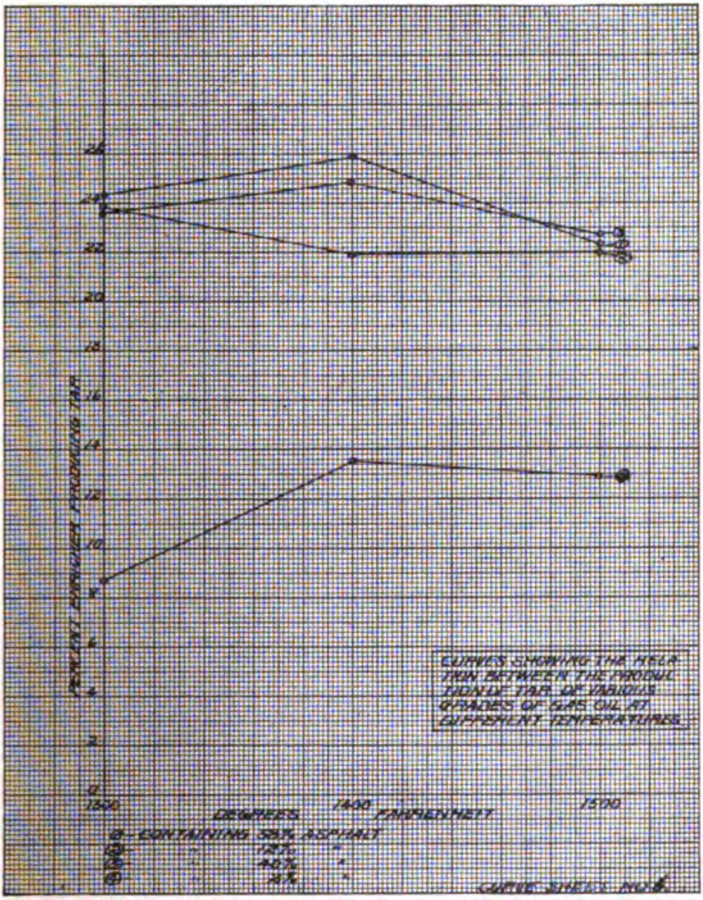
These curves illustrate a method of comparing the relative values of gas oils. The predominating factor, the sulphur content being within reasonable limits, is the amount of gas that the oil will produce, next of importance will be the amount of carbon produced under given conditions. The amount of asphalt basic oils present in the sample is indicated on each respective sheet. It will be noticed that the greater the percentage of asphalt the greater is the production of both carbon and tar, and the gas is correspondingly reduced.



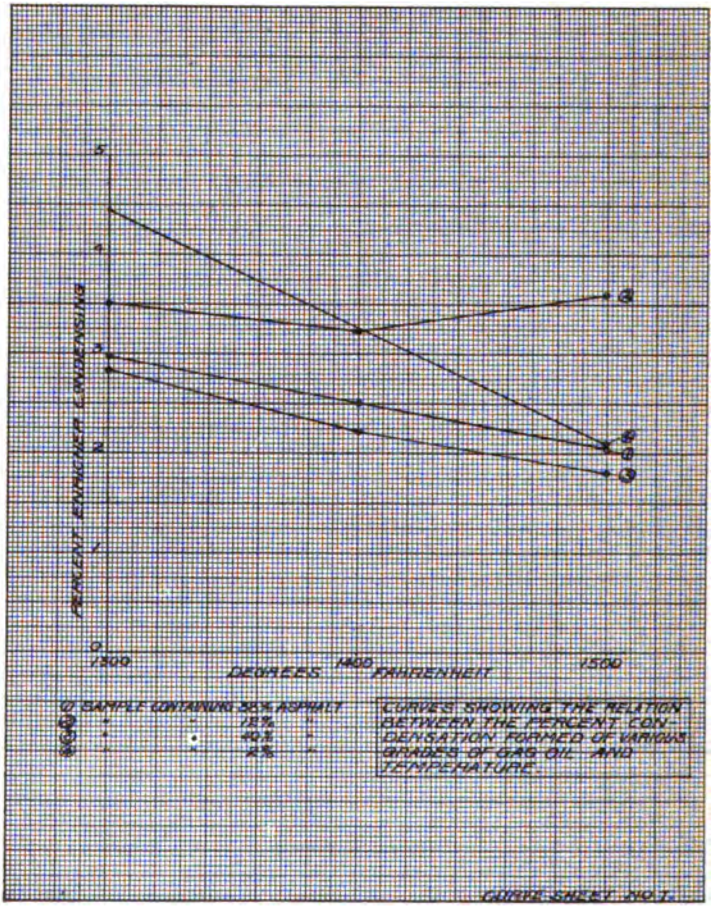
Since it is apparent that asphalt basic oils will render an oil worthless for the enrichment of water gas if present in sufficient quantity, the question remains how much of asphalt basic oils will be permissible? This, of course, depends upon the number of pounds of carbon that are capable of being consumed by the excess oxygen that can be supplied to the carbureter during the "blow," any amount which is formed in excess of this will remain deposited in the checker brick. Suppose, for example, that 3,000 cubic feet of air are supplied to the carbureter per minute during a 4-minute "blow," in ex-



cess of the volume of air necessary for the complete combustion of the producer gas in bringing the temperature of the carbureter to the desired value. Assuming that it will require 17.3 pounds of air per pound of carbon for complete combustion, this weight of the total air supplied during 4 minutes will be capable of combining with 52.9 pounds of carbon. Assuming furthermore that 35 gallons of enricher are used during the "run," then the weight of carbon capable of being

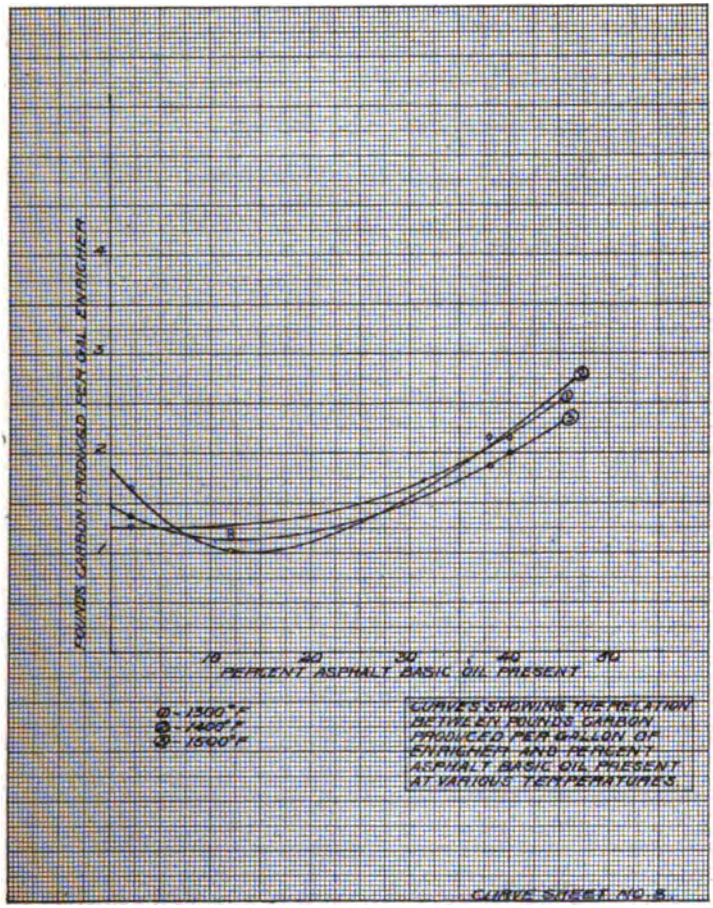


consumed by the volume of air supplied represents 20.8 per cent. by weight of the enricher used, or approximately 1.5 pounds per gallon of enricher. Therefore, this amount of

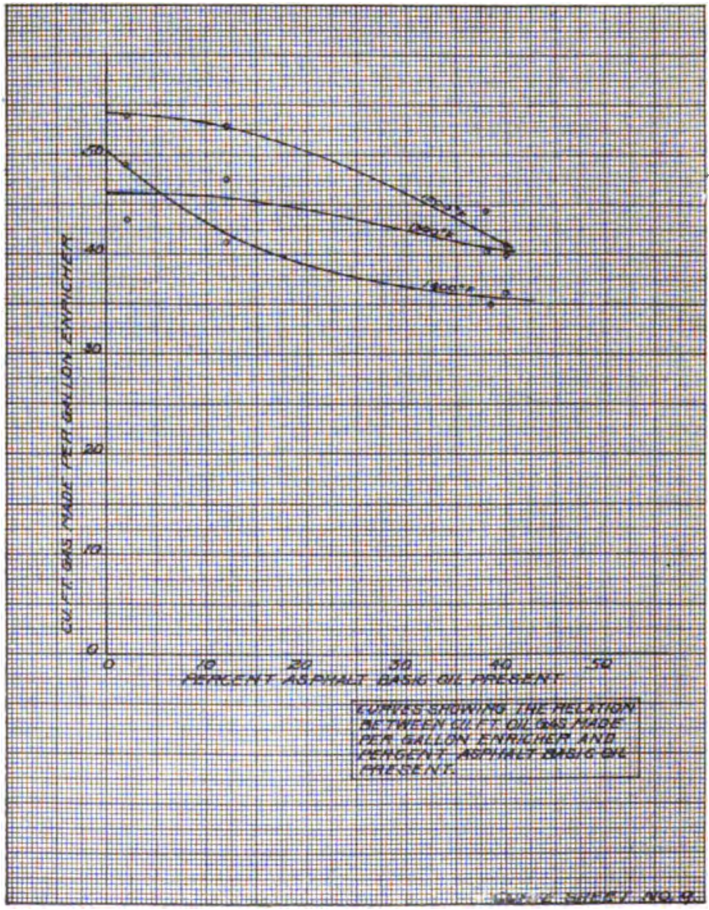


carbon constitutes the maximum amount permissible under the assumed conditions.

Curve Sheet No. 5 shows the relation between the per cent. of enricher producing carbon and temperature. They illustrate not only what occurs in the gas machine when oils running high in asphaltum are used, but also that the formation of carbon undergoes very little change due to variations in temperature and that the trouble cannot be remedied in this manner.



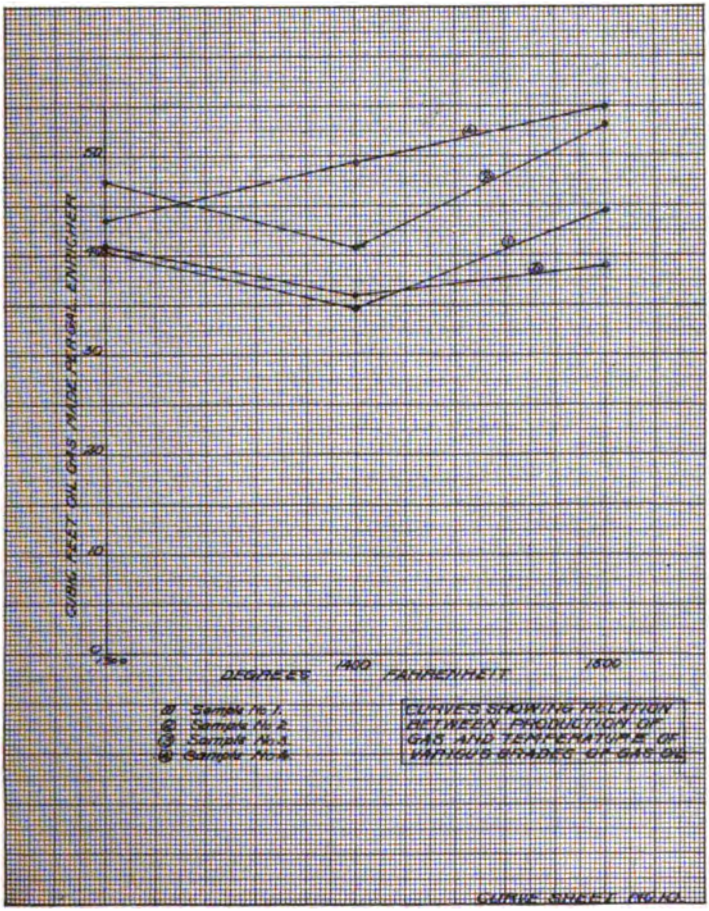
Curve Sheets Nos. 6 and 7 show the relation between the per cent. of enricher producing tar and the per cent. of enricher condensing in the cooler, respectively, to temperature. Here again the oil running high in asphaltum distinguishes itself from the oil running low in asphaltum. The former



CURVES SHOWING THE RELATION BETWEEN CU. FT. OIL GAS MADE PER GALLON ENRICHER AND PERCENT ASPHALT BASIC OIL PRESENT.

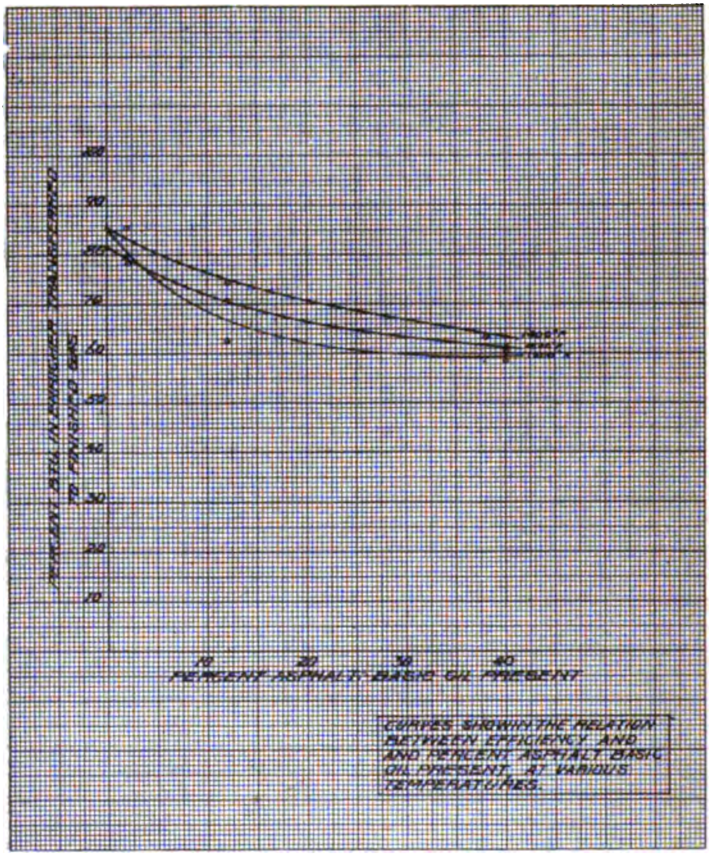
produces less tar as the temperature increases, whereas the latter produces more tar. The condensation becomes less as the temperature increases which shows that the gas is rendered in a more permanent state. This, however, has no bearing on the amount of asphaltum present.

The detrimental effect of the presence of an excessive amount of asphalt basic oil is shown further on Curve Sheets Nos. 8 to 12. It causes a rapid increase in the production of carbon; it decreases the gas producing qualities of the oil, and



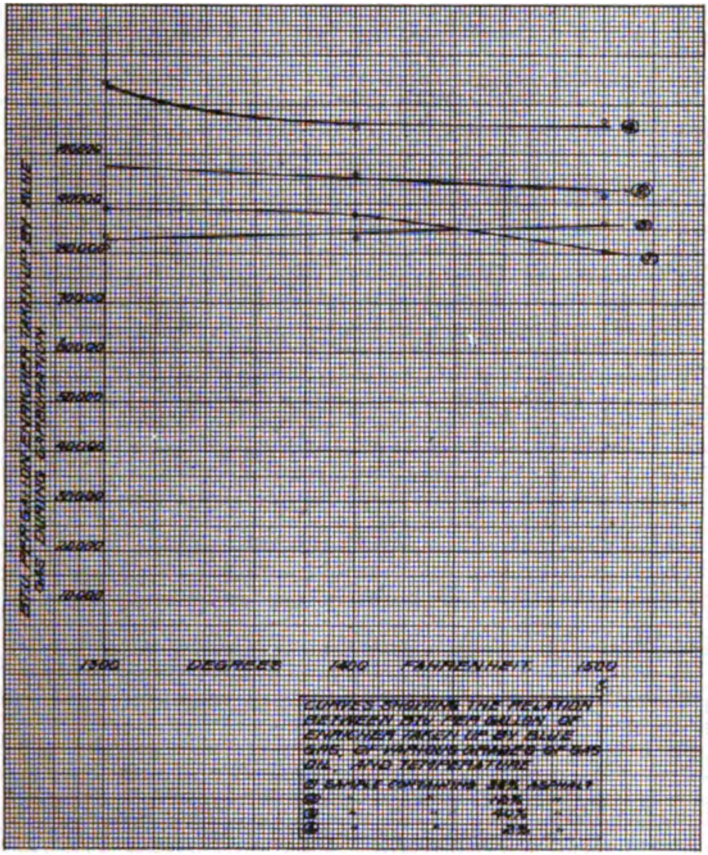
the actual number of heat units per gallon of enricher transferred to the finished gas suffer a corresponding loss.

Attention is called to the fact that the conditions under which these cracking tests were performed were more favorable to the development of good results than those in actual practice, in view of the fact that the cracking tube was not permitted to stop up, the heating surface always remaining the same, and the temperature was kept uniform. The carbureter



CURVE SHEET NO. 11.

of the gas machine will undergo rapid changes as the carbon begins to collect in the checker brick, and this will tend to aggravate the effect still more.



CURVE SHEET NO. 12.

The determinations made of the naphthalene produced in these tests do not seem to bear any relation to the presence of asphalt basic oils. Although, in actual practice, as stated above, the formation of carbon in the carbureter will partly stop up the spacing between the checker brick, and cause the carbureter to become heated excessively in some places, and to remain cold in other places, the resulting local high temperature will cause an excessive amount of naphthalene to be produced.

It will be noticed that some of the curves giving the relation between the production of gas, of tar and of carbon, to temperature, show greater values for low temperatures, of oils running high in paraffine base, than would be expected. This is probably due to the fact that there are other factors involved which will affect the results.

This investigation is not to be considered as being complete or final, as a matter of fact it covers merely a portion of the work that might be done in order to develop all the facts and to obtain all the information that should be obtained.

A good deal of additional information could be obtained, which would be beneficial as well as extremely interesting, by providing for an equipment of greater capacity. At least from 8 to 10 cubic feet of gas should be made for one test, this would be a sufficient quantity for the determination of more details, the yield of tar would be sufficient to be used for further investigation, in order to determine its properties and composition. There would also be enough free carbon formed in order to determine the same by direct weight with a reasonable degree of accuracy. Some very interesting data can be obtained by selecting certain distillates and mixing the same in definite proportions, varying only such qualities as are being investigated.

It has been shown that the production of gas from a given grade of gas oil bears a definite relation to the percentage of paraffine basic oil contained therein. It has also been shown that the formation of free carbon varies with the amount of asphalt basic oil present, and that the troubles resulting therefrom can not be remedied by methods of operation. The use of gas oil containing more than from 20 to 25 per cent. of asphalt basic oil will create trouble, which will be multiplied in proportion to the increase of this component.

Sample Calculation Sheet.

Kind of gas oil used	Sample No. 4
Sp. gr. at 60° F.	0.831
Paraffine series oils by acid test (per cent.)	98
Asphalt series oils by acid test (per cent.)	2
Flash point (deg. F.)	230

Fractional Distillation.

Below 150° C.	traces
From 150 to 200° C.	traces
From 200 to 250° C.	27.6
From 250 to 300° C.	50.2
Above 300° C.	21.0
Residue (grams)	1.3
Sample (cc.)	100

Cracking Test.

Temperature of carbureter (deg. F.)	1,400
Temperature of blue gas used (deg. F.)	88
Temperature of finished gas made (deg. F.)	85
Atmospheric pressure (in.)	29.34
Correction factor	0.910 0.902
Temperature of gas oil (deg. F.)	106
Duration of test (min.)	44

	Finished gas analysis per cent.	Blue gas analysis per cent.
CO_2	7.0	7.5
O_2	0.4	0.1
Illum.	8.8	0.3
CO	28.7	34.5
CH_4	15.4	2.7
H_2	34.7	51.5
N_2	5.0	3.4

Total enricher used (cc.)	28.4
Sp. gr. of enricher at 106° F.	0.814
Weight of finished gas per cu. ft. (lbs.)	0.04830
Weight of blue gas per cu. ft. (lbs.)	0.08096
Total finished gas made (cu. ft.)	2.434
Total blue gas used (cu. ft.)	2.065

Weight of finished gas = 2.434 × 0.04830 = 0.11756 lb.

Weight of blue gas used = 2.065 × 0.04096 = 0.08458 lb.

Weight of tar recovered .... 3.113 grams

3.113 × 0.002204 = 0.00686 lb.

Weight of condensation in cooler = 0.323 × 0.002204 = 0.00071 lb.
Weight of enricher used = 28.4 × 0.814 = 23,118 grams
= 23.118 × 0.002204 = 0.05095 lb.
Weight of enricher per gallon = 0.814 × 8.34 = 6.789 lbs.

Number of gals. of enricher used = $\frac{0.05095}{6.789}$ = 0.00750 gal.

B. t. u. of finished gas 572 — calorimeter
595 — calculated
B. t. u. of blue gas 320
Naphthalene produced 0.12 lb./x cu. ft.
Raw material used = 0.08458 + 0.05095 = 0.13553 lb.
Weight of finished product = 0.11756 lb.
Weight of enricher not producing gas = 0.13553 — 0.11756 = 0.01797 lb.
Weight of free carbon produced = 0.01797—(0.00686+0.00071) = 0.01040 lb.
Weight of oil gas produced = 0.11756 — 0.8458 = 0.03298 lb.

Per cent. enricher producing oil gas = $\frac{0.03298}{0.05095} \times 100 = 64.73$

Per cent. enricher producing tar = $\frac{0.00686}{0.05095} \times 100 = 13.46$

Per cent. enricher producing carbon = $\frac{0.01040}{0.05095} \times 100 = 20.41$

Per cent. enricher condensing = $\frac{0.00071}{0.05095} \times 100 = 1.39$

Cu. ft. oil gas made = 2.434 — 2.065 = 0.369

Cu. ft. oil gas made per gal. enricher = $\frac{0.369}{0.00750}$ = 49.20

Gals. enricher used per M cu. ft. gas made = $\frac{0.00750}{2.434} \times 1{,}000 = 3.081$

Per cent. of oil gas in total = $\frac{0.369}{2.434} \times 100 = 15.16$

Per cent. of blue gas in total = $\frac{2.065}{2.434} \times 100 = 84.84$

Total B.t.u. supplied by blue gas per cu. ft. finished gas = 320×0.8484=271
Total B. t. u. supplied by oil gas per cu. ft. finished gas=595—271=324

Per cent. B. t. u. supplied by oil gas = $\frac{324}{595} \times 100 = 54.45$

Per cent. B. t. u. supplied by blue gas = $\frac{271}{595} \times 100 = 45.54$

Total B. t. u. per gal. enricher = $\frac{324}{0.003081}$ = 105,161

Total B. t. u. per lb. enricher = $\frac{105{,}161}{5.80}$ = 15,489

Per cent. of B.t.u. in enricher transferred to finished gas =

$$\frac{15{,}489}{19{,}775} \times 100 = 78.27$$

Pounds carbon produced per gal. enricher $= \frac{0.01040}{0.00750} = 1.387$

Pounds carbon produced per gal. enricher per per cent. asphalt present $=$

$$\frac{1.387}{2} = 0.6935$$

Pounds naphthalene produced per gal. enricher $= \frac{0.12}{3.081 \times 10} = 0.00389$

Pounds naphthalene produced per gal. enricher per per cent. asphalt present $= \frac{0.00389}{2} = 0.00195$

Total CO_2 present in blue gas used $= 2.065 \times 0.075 = 0.1549$ cu. ft.

Per cent. CO_2 present in finished gas (calculated) $= \frac{0.1549}{2.434} = 6.3$

Per cent. CO_2 present in finished gas (by analysis) $= 7.0$

SAMPLE OIL NO. 1.—DATA AND RESULT SHEET.

Specific gravity at 60° F.	0.872
Paraffine series oils, by acid test (per cent.)	62
Asphalt series oils, by acid test (per cent.)	38
Flash point (deg. F.)	192
Fractional distillation, percentage by volume:	
Total sample (cc.)	100
Below 150° C. (per cent.)	0.0
From 150° to 200° C. (per cent.)	2.0
From 200° to 250° C. (per cent.)	22.6
From 250° to 300° C. (per cent.)	29.0
Above 300° C. (per cent.)	43.0
Residue (grams)	3.5

Cracking Test.

Temperature of carbureter (deg. F.)	1,300	1,400	1,500
Temperature of blue gas used (meter outlet) (deg. F.)	89	77	87
Temperature of finished gas made (meter outlet) (deg. F.)	84	77	86
Barometer (in.)	29.3	29.3	29.2
Temperature of gas oil (deg. F.)	109	100	118.5
Duration of test (min.)	31	29	17

Gas Analysis.

	Blue gas	Finished gas	Blue gas	Finished gas	Blue gas	Finished gas
CO_2	11.4	9.6	13.4	10.2	10.0	8.0
O_2	0.2	1.0	0.3	0.5	0.0	0.8
Illum.	0.3	9.8	0.5	13.4	0.2	6.6
CO	26.9	22.2	23.6	18.9	30.5	23.2
CH_4	2.9	13.5	2.1	17.9	1.4	18.6
H_2	47.3	34.5	56.8	34.2	54.2	36.6
N_2	11.0	9.4	3.3	4.9	3.7	6.2

Enricher used (cc.)	34.0	49.0	23.4
Sp. gr. of enricher at temp. used	0.854	0.858	0.851
Weight of enricher used (lbs.)	0.06400	0.09266	0.04395
Weight of enricher per gal. at temp. as used (lbs.)	7.122	7.156	7.097
No. of gallons of enricher used	0.00898	0.01294	0.00619
Weight of finished gas per cu. ft. (lbs.)	0.05020	0.04922	0.04644
Weight of blue gas per cu. ft. (lbs.)	0.04544	0.03902	0.04056
Total finished gas made, corrected (cu. ft.)	2.417	2.411	1.482
Total blue gas used, corrected (cu. ft.)	2.055	1.962	1.207
Weight of finished gas made (lbs.)	0.12133	0.11867	0.06882
Weight of blue gas used (lbs.)	0.09338	0.07656	0.04895
Weight of tar recovered (lbs.)	0.01561	0.02408	0.00977
Weight of condensation collected (lbs.)	0.00098	0.00230	0.00089
B. t. u. of blue gas per cu. ft. calculated	284	299	297
B. t. u. of finished gas per cu. ft. calculated	572	696	574
B. t. u. of finished gas per cu. ft. (by calorimeter)	567	677	—
B. t. u. of enricher per lb. (by calorimeter	19,532	19,532	19,532
Naphthalene produced (lbs. per 10,000 cu. ft.)	0.22	0.21	0.14
Weight of enricher not producing gas (includes tar, carbon and condensation) (lbs.)	0.03605	0.05055	0.02408
Weight of free carbon formed (lbs.)	0.01946	0.02417	0.01342
Weight of oil gas made (lbs.)	0.02795	0.04211	0.01987
Oil gas made (cu. ft.)	0.362	0.449	0.275
Oil gas made per gal. enricher (cu. ft.)	40.31	34.7	44.42
Enricher used per 1,000 cu. ft. of gas made (gals.)	3.715	5.11	4.109
Per cent. enricher producing oil gas	43.67	45.5	45.21
Per cent. enricher producing tar	24.39	25.9	22.23
Per cent. enricher producing carbon	30.41	26.1	30.53
Per cent. enricher condensing	1.53	2.5	2.03
Per cent. of oil gas in total	14.98	18.62	18.55
Per cent. of blue gas in total	85.02	81.38	81.45
Total B. t. u. supplied by blue gas per cu. ft. finished gas	241	243	242
Total B. t. u. supplied by oil gas per cu. ft. finished gas	331	453	332
Per cent. B. t. u. supplied by oil gas	57.86	65.08	57.83
Per cent. B. t. u. supplied by blue gas	42.13	34.92	42.17

Total B. t. u. supplied per gal. enricher	89,098	88,650	80,798
Total B. t. u. supplied per lb. enricher.	12,509	12,390	11,385
Per cent. B. t. u. in enricher transferred to finished gas	64.04	63.43	58.28
Carbon produced per gal. of enricher (lbs.)	2.167	1.867	2.168
Carbon produced per gal. of enricher per per cent. asphalt present (lbs.)	0.05703	0.0491	0.05705
Naphthalene produced per gal. enricher (lbs.)	0.00592	0.0041	0.00341
Naphthalene produced per gal. enricher per per cent. asphalt present (lbs.)	0.000156	0.000108	0.000089
Total CO_2 present in blue gas used (cu. ft.)	0.2343	0.2629	0.1207
Per cent CO_2 present in finished gas (calculated)	9.69	10.0	8.1
Per cent. CO_2 present in finished gas (by analysis)	9.6	10.2	8.0

SAMPLE OIL NO. 2.—DATA AND RESULT SHEET.

Specific gravity at 60° F.	0.821
Paraffine series oils, by acid test (per cent.)	88
Asphalt series oils, by acid test (per cent.)	12
Flash point (deg. F.)	100

Fractional Distillation, Percentage by Volume.

Total sample (cc.)	100
Below 150° C. (per cent.)	15.2
From 150° to 200° C. (per cent.)	29.4
From 200° to 250° C. (per cent.)	31.6
From 250° to 300° C. (per cent.)	16.2
Above 300° C. (per cent.)	6.4
Residue (grams)	1.4

Cracking Tests.

Temperature of carbureter (deg. F.)	1,300	1,400	1,500
Temperature of blue gas used (meter outlet) (deg. F.)	86	83	79
Temperature of finished gas made (meter outlet) (deg. F.)	86	82	79
Barometer (in.)	29.24	29.3	29.34
Temperature of gas oil (deg. F.)	107.3	109	107
Duration of test (min.)	30	17	22

Gas Analysis.

	Blue gas	Finished gas	Blue gas	Finished gas	Blue gas	Finished gas
CO_2	8.0	7.5	6.6	6.6	7.8	6.4
O	0.2	1.4	0.4	0.5	0.4	0.8
Illum.	0.0	10.9	0.2	13.7	0.2	11.6
CO	33.2	22.2	34.7	24.4	33.2	23.3
CH_4	1.7	21.9	2.5	20.5	1.7	20.8
H_2	50.7	27.6	52.0	29.2	53.3	30.6
N_2	6.2	8.5	3.6	5.1	3.4	6.5

Enricher used (cc.)	48.0	49	49
Sp. gr. of enricher at temp. used	0.804	0.803	0.804
Weight of enricher used (lbs.)	0.08506	0.08683	0.08683
Weight of enricher per gal. (lbs.)	6.705	6.705	6.705
No. of gals. of enricher used	0.01268	0.01295	0.01295
Weight of finished gas per cu. ft. (lbs.)	0.05144	0.05031	0.04919
Weight of blue gas per cu. ft. (lbs.)	0.04205	0.04033	0.04020
Total finished gas made, corrected (cu. ft.)	2.210	2.437	2.520
Total blue gas used, corrected (cu. ft.)	1.607	1.809	1.830
Weight of finished gas made, corrected (lbs.)	0.11368	0.12260	0.12396
Weight of blue gas used, corrected (lbs.)	0.06757	0.07295	0.07357
Weight of tar recovered (lbs.)	0.02033	0.01903	0.01918
Weight of condensation collected (lbs.)	0.00306	0.00278	0.00313
B. t. u. of blue gas per cu. ft. (calculated)	294	318	307
B. t. u. of finished gas per cu. ft. (calculated)	678	747	694
B. t. u. of finished gas per cu. ft. (by calorimeter)	693	715	677
B. t. u. of enricher per lb.	19,251	19,251	19,251
Naphthalene produced (lbs. per 10,000 cu. ft.)	0.72	0.59	0.46
Weight of enricher not producing gas (includes tar, carbon and condensation) (lbs.)	0.03895	0.03718	0.03644
Weight of free carbon formed (lbs.)	0.01556	0.01537	0.01413
Weight of oil gas made (lbs.)	0.04611	0.04965	0.05039
Oil gas made (cu. ft.)	0.603	0.628	0.690
Oil gas made per gal. of enricher (cu. ft.)	47.5	40.8	53.2

Enricher used per 1,000 cu. ft. gas made (gals.)	5.74	5.31	5.14
Per cent. enricher producing oil gas	54.2	57.18	58.0
Per cent. enricher producing tar	23.9	21.91	22.0
Per cent. enricher producing carbon	18.2	17.70	16.2
Per cent. enricher condensing	3.5	3.21	3.60
Per cent. of oil gas in total	27.2	25.77	27.3
Per cent. of blue gas in total	72.7	74.23	72.6
Total B. t. u. supplied by blue gas per cu. ft. finished gas	213	236	222
Total B. t. u. supplied by oil gas, per cu. ft. finished gas	465	511	472
Per cent. B. t. u. supplied by oil gas	68.58	68.40	67.89
Per cent. B. t. u. supplied by blue gas	31.42	31.60	31.11
Total B. t. u. per gal. of enricher	81,010	96,233	91,328
Total B. t. u. per lb. of enricher	12,077	14,352	13,695
Per cent. B. t. u. in enricher transferred to finished gas	62.68	74.55	71.14
Carbon produced per gal. of enricher (lbs.)	1.23	1.179	1.091
Carbon produced per gal. of enricher per per cent. of asphalt present (lbs.)	0.1025	0.09825	0.0909
Naphthalene produced per gal. enricher (lbs.)	0.125	0.01111	0.0089
Naphthalene produced per gal. of enricher per per cent. asphalt present (lbs.)	0.00104	0.00093	0.00074
Total CO_2 present in blue gas used	0.12856	0.1194	0.14274
Per cent. CO_2 present in finished gas (calculated)	5.8	4.9	5.6
Per cent. CO_2 present in finished gas (by analysis)	7.5	6.6	6.4

SAMPLE OIL NO. 3.—DATA AND RESULT SHEET.

Specific gravity at 60° F.	0.892
Paraffine series oils, by acid test (per cent.)	60
Asphalt series oils, by acid test (per cent.)	40
Flash point (deg. F.)	240

Fractional Distillation, Percentage by Volume.

Total sample (cc.)	100
Below 150° C.	None
From 150° to 200° C.	Traces
From 200° to 250° C. (per cent.)	9.2
From 250° to 300° C. (per cent.)	25.0
Above 300° C. (per cent.)	60.0
Residue (grams)	5.9

Cracking Tests.

Temperature of carbureter (deg. F.)	1,300	1,400	1,500
Temperature of blue gas used (meter outlet) (deg. F.)	87	79	84
Temperature of finished gas made (meter outlet) (deg. F.)	84	78	80
Barometer (in.)	29.3	29.34	29.3
Temperature of gas oil (deg. F.)	112	102	105
Duration of test (min.)	31	29	31

Gas Analysis.

	Blue gas	Finished gas	Blue gas	Finished gas	Blue gas	Finished gas
CO_2	9.5	8.0	5.6	6.6	8.0	6.6
O	0.2	0.8	0.4	0.8	0.0	0.7
Illum.	0.3	12.4	0.3	14.2	0.6	12.9
CO	31.5	24.0	32.3	22.9	32.4	23.0
CH_4	2.7	17.5	2.5	19.3	3.2	20.8
H_2	52.3	33.6	54.0	31.1	53.5	30.0
N_2	3.5	3.7	4.9	5.1	2.3	5.0

Enricher used (cc.)	49	49	49
Sp. gr. of enricher at temp as used	0.873	0.877	0.876
Weight of enricher used (lbs.)	0.09428	0.09471	0.09460
Weight of enricher per gal. at temp. as used (lbs.)	7.281	7.314	7.306
No. of gals. of enricher used	0.01295	0.01295	0.01294
Weight of finished gas per cu. ft. (lbs.)	0.04886	0.04941	0.04961
Weight of blue gas per cu. ft. (lbs.)	0.04127	0.03853	0.03963
Total finished gas made, corrected (cu. ft.)	2.564	2.239	2.430
Total blue gas used, corrected (cu. ft.)	2.033	1.772	1.913
Weight of finished gas made, corrected (lbs.)	0.12528	0.11063	0.12055
Weight of blue gas used, corrected (lbs.)	0.08390	0.06827	0.07581
Weight of tar recovered (lbs.)	0.02226	0.02360	0.02150
Weight of condensation collected (lbs.)	0.00268	0.00209	0.00171
B. t. u. of blue gas per cu. ft. (calculated)	313	319	333
B. t. u. of finished gas per cu. ft. (calculated)	671	734	720
B. t. u. of finished gas per cu. ft. (by calorimeter)	667	718	697
B. t. u. of enricher per lb.	19,042	19,042	19,042

Naphthalene produced (lbs. per 10,000 cu. ft.)	0.42	0.08	0.43
Weight of enricher not producing gas (includes tar, carbon, condensation) (lbs.)	0.05290	0.05235	0.04986
Weight of free carbon formed (lbs.)	0.02796	0.02666	0.02665
Oil gas made (lbs.)	0.04138	0.04236	0.04474
Oil gas made (cu. ft.)	0.531	0.467	0.517
Oil gas made per gal. of enricher (cu. ft.)	41.0	36.06	39.94
Enricher used per 1,000 cu. ft. of gas made (gals.)	5.051	5.784	5.32
Per cent. enricher producing oil gas	43.89	44.73	47.29
Per cent. enricher producing tar	23.61	25.92	22.72
Per cent. enricher producing carbon	29.66	28.14	28.17
Per cent. enricher condensing	2.84	2.21	1.80
Per cent. of oil gas in total	20.71	20.85	21.27
Per cent. of blue gas in total	79.29	29.14	78.72
Total B. t. u. supplied by blue gas per cu. ft. finished gas	248	252	262
Total B. t. u. supplied by oil gas per cu. ft. finished gas	423	482	458
Per cent. B. t. u. supplied by oil gas	63.04	65.67	63.61
Per cent. B. t. u. supplied by blue gas	36.96	34.33	36.39
Total B. t. u. supplied per gal. of enricher	83,745	83,333	86,090
Total B. t. u. supplied per lb. of enricher	11,502	11,393	11,783
Per cent. B. t. u. in enricher transferred to finished gas	60.40	58.78	61.87
Carbon produced per gal. of enricher (lbs.)	2.159	2.059	2.059
Carbon produced per gal. enricher per per cent. asphalt present (lbs.)	0.05398	0.05148	0.0514
Naphthalene produced per gal. of enricher (lbs.)	0.00832	0.00138	0.0080
Naphthalene produced per gal. of enricher per per cent. asphalt present (lbs.)	0.000208	0.0000345	0.0002
Total CO_2 present in blue gas (cu. ft.)	0.1931	0.0992	0.15304
Per cent. CO_2 present in finished gas (calculated)	7.5	4.43	6.3
Per cent. CO_2 present in finished gas (by analysis)	8.0	6.6	6.6

SAMPLE OIL NO. 4.—DATA AND RESULT SHEETS.

Specific gravity at 60° F.	0.831
Paraffine series oils, by acid test (per cent.)	98
Asphalt series oils, by acid test (per cent.)	2
Flash point (deg. F.)	230

Fractional Distillation, Percentage by Volume.

Total sample (cc.)	100
Below 150° C.	Traces
From 150° to 200° C.	Traces
From 200° to 250° C. (per cent.)	27.6
From 250° to 300° C. (per cent.)	50.2
Above 300° C. (per cent.)	21.0
Residue (grams)	1.3

Cracking Tests.

Temperature of carbureter (deg. F.)	1,310	1,400	1,500
Temperature of blue gas used (meter outlet) (deg. F.)	85.5	88.0	77
Barometer (in.)	29.2	29.34	29.37
Temperature of gas oil (deg. F.)	104.5	106	101
Duration of test (min.)	——	44	31

Gas Analysis.

	Blue gas	Finished gas	Blue gas	Finished gas	Blue gas	Finished gas
CO$_2$	8.6	7.2	7.5	7.0	13.1	9.3
O$_2$	0.0	0.4	0.1	0.4	0.1	0.3
Illum.	0.2	8.5	0.3	8.8	0.0	10.6
CO	32.2	26.5	34.5	28.7	24.3	21.0
CH$_4$	2.2	16.2	2.7	15.4	3.8	19.6
H$_2$	54.7	35.7	51.5	34.7	50.4	31.1
N$_2$	2.1	5.5	3.4	5.0	8.3	8.1

Enricher used (cc.)	24.4	28.4	35
Sp. gr. of enricher at temp. as used	0.815	0.814	0.816
Weight of enricher used at temp. as used (lbs.)	0.04383	0.05095	0.06295
Weight of enricher per gal. at tem. as used (lbs.)	6.80	6.789	6.805
No. of gals. of enricher used	0.00644	0.00759	0.00925
Weight of finished gas per cu. ft. (lbs.)	0.04744	0.0483	0.05041
Weight of blue gas per cu. ft. (lbs.)	0.03937	0.04096	0.04374
Total finished gas made, corrected (cu. ft.)	2.321	2.434	2.342
Total blue gas used, corrected (cu. ft.)	2.041	2.065	1.828

Weight of finished gas made (lbs.)	0.11011	0.11756	0.11806
Weight of blue gas used (lbs.)	0.08035	0.08458	0.07996
Weight of tar recovered (lbs.)	0.00383	0.00686	0.00814
Weight of condensation collected (lbs.)	0.00197	0.00071	0.00130
B. t. u. of blue gas per cu. ft. (calculated)	315	320	291
B. t. u. of finished gas per cu. ft. (calculated)	595	595	651
B. t. u. of finished gas per cu. ft. (by calorimeter)	588	572	—
B. t. u. of enricher per lb.	19,775	19,775	19,775
Naphthalene produced (lbs. per 10,000 cu. ft.)	0.40	0.12	——
Weight of enricher not producing gas (includes carbon, tar, condensation) (lbs.)	0.01407	0.01797	0.02485
Weight of free carbon formed (lbs.)	0.00827	0.01040	0.01541
Weight of oil gas made (lbs.)	0.02976	0.03298	0.03810
Oil gas made (cu. ft.)	0.280	0.369	0.514
Oil gas made per gal. of enricher (cu. ft.)	43.47	49.20	54.49
Enricher used per 1,000 cu. ft. of gas made (gal.)	2.77	3.081	3.949
Per cent. enricher producing oil gas	67.89	64.73	60.52
Per cent. enricher producing tar	8.73	13.46	12.93
Per cent. enricher producing carbon	18.95	20.41	24.48
Per cent. enricher condensing	4.43	1.39	2.07
Per cent. of oil gas in total	12.06	15.16	21.95
Per cent. of blue gas in total	87.93	84.84	78.05
Total B. t. u. supplied by blue gas per cu. ft. finished gas	277	271	227
Total B. t. u. supplied by oil gas per cu. ft. finished gas	318	324	424
Per cent. B. t. u. supplied by oil gas	53.44	54.45	65.13
Per cent. B. t. u. supplied by blue gas	46.56	45.55	34.87
Total B. t. u. supplied per gal. of enricher	114,801	105,161	107,368
Total B. t. u. supplied per lb. of enricher	16,882	15,489	15,777
Per cent. B. t. u. in enricher transferred to finished gas	85.37	78.27	79.78
Carbon produced per gal. of enricher (lbs.)	1.284	1.387	1.666
Carbon produced per gal. enricher per per cent. asphalt present (lbs.)	0.642	0.6935	0.833
Naphthalene produced per gal. of enricher (lbs.)	0.00144	0.00389	——

Naphthalene produced per gal. of enricher per per cent. asphalt present (lbs.)	0.00072	0.00195	——
Total CO_2 present in blue gas (cu. ft.)	0.17552	0.1549	0.2395
Per cent. CO_2 present in finished gas (calculated)	7.5	6.3	10.2
Per cent. CO_2 present in finished gas (by analysis)	7.2	7.0	9.3

Sample Oils Nos. 1, 2, 3, 4.—Cracking Up Tests at 1,300° F. Data and Results Sheets.

Sample number	4	2	1	3
Sp. gr. at 60° F.	0.831	0.821	0.872	0.892
Paraffine series oils, by acid test (per cent.)	98	88	62	60
Asphalt series oils, by acid test (per cent.)	2	12	38	40
Flash point (deg. F.)	230	100	192	—
Temp. of carbureter (deg. F.)	1,310	1,300	1,300	1,300
Temp. of blue gas used (meter outlet) (deg. F.)	85.5	86	89	87
Temp. of finished gas made (meter outlet) (deg. F.)	86.0	86	84	84
Barometer (in.)	29.2	29.24	29.3	29.3
Temp. of gas oil (deg. F.)	104.5	107.3	109	112
Duration of test (min.)	——	30	31	31
Enricher used (cc.)	24.4	48.0	34.0	49
Sp. gr. of enricher at temp. as used	0.815	0.804	0.854	0.873
Wt. of enricher used (lbs.)	0.04383	0.8506	0.06400	0.09428
Wt. of enricher per gal. (lbs.)	6.80	6.705	7.122	7.281
No. of gals. of enricher used	0.00644	0.01268	0.00898	0.01295
Wt. of finished gas per cu. ft. (lbs.)	0.04744	0.05144	0.05020	0.04886
Wt. of blue gas per cu. ft. (lbs.)	0.03937	0.04205	0.04544	0.04127
Total finished gas made, corrected (cu. ft.)	2.321	2.210	2.417	2.564
Total blue gas used, corrected (cu. ft.)	2.041	1.607	2.055	2.033
Wt. of finished gas made, corrected (lbs.)	0.11011	0.11368	0.12133	0.12528
Wt. of blue gas used, corrected (lbs.)	0.08035	0.06757	0.09338	0.08390
Wt. of tar recovered (lbs.)	0.00383	0.02033	0.01561	0.02226

Wt. of condensation collected (lbs.)	0.00197	0.00306	0.00098	0.00268
B. t. u. of blue gas per cu. ft. (calculated)	315	294	284	313
B. t. u. of finished gas per cu. ft. (calculated)	595	678	572	671
B. t. u. of finished gas per cu. ft. (by calorimeter)	588	693	567	667
B. t. u. of enricher per lb.	19,775	19,251	19,532	19,042
Naphthalene produced (lbs. per 10,000 cu. ft.)	0.40	0.72	0.22	0.42
Wt. of enricher not producing gas (includes tar, carbon, condensation) (lbs.)	0.01407	0.03895	0.03605	0.05290
Wt. of free carbon formed (lbs.)	0.00827	0.01556	0.01946	0.02796
Wt. of oil gas made (lbs.)	0.02976	0.04611	0.02795	0.04138
Oil gas made (cu. ft.)	0.280	0.603	0.362	0.531
Oil gas made per gal of enricher (cu. ft.)	43.47	47.5	40.31	41.0
Enricher used per 1,000 cu. ft. of gas made (gals.)	2.77	5.74	3.715	5.051
Per cent. enricher producing oil gas	67.89	54.2	43.67	43.89
Per cent. enricher producing tar	8.73	23.9	24.39	23.61
Per cent. enricher producing carbon	18.95	18.2	30.41	29.66
Per cent. enricher producing condensing	4.43	3.5	1.53	2.84
Per cent. of oil gas in total	12.06	27.2	14.98	20.71
Per cent. of blue gas in total	87.93	72.7	85.02	79.29
Total B. t. u. supplied by blue gas per cu. ft. finished gas.	277	213	241	248
Total B. t. u. supplied by oil gas per cu. ft. finished gas	318	465	331	423
Per cent. B. t. u. supplied by oil gas	53.44	68.58	57.86	63.04
Per cent. B. t. u. supplied by blue gas	46.56	31.42	42.13	36.96
Total B. t. u. supplied per gal. of enricher	114,801	81,010	89,098	83,745
Total B. t. u. per lb. of enricher	16,882	12,077	12,509	11,502
Per cent. B. t. u. in enricher transferred to finished gas.	85.37	62.68	64.04	60.40

Carbon produced per gal. of enricher (lbs.)	1.284	1.23	2.167	2.159
Carbon produced per gal. of enricher per per cent. of asphalt present (lbs.)	0.642	0.1025	0.05703	0.05398
Naphthalene produced per gal of enricher (lbs.)	0.00144	0.125	0.00592	0.00832
Naphthalene produced per gal. of enricher per per cent. of asphalt present (lbs.)	0.00072	0.00104	0.000156	0.000208

SAMPLE OILS NOS. 1, 2, 3, 4.—CRACKING UP TESTS AT 1,400° F.
DATA AND RESULTS SHEET.

Sample number	4	2	1	3
Sp. gr. at 60° F.	0.831	0.821	0.872	0.892
Paraffine series oils, by acid test (per cent.)	98	88	62	60
Asphalt series oils, by acid test (per cent.)	2	12	38	40
Flash point (deg. F.)	230	100	192	—
Temp. of carbureter (deg. F.)	1,400	1,400	1,400	1,400
Temp of blue gas used (meter outlet) (deg. F.)	88.0	83	77	79
Temp. of finished gas made (meter outlet) (deg. F.)	85.0	82	77	78
Barometer (in.)	29.34	29.3	29.3	29.34
Temp. of gas oil (deg. F.)	106	109	100	102
Duration of test (min.)	44	17	29	29
Enricher used (cc.)	28.4	49	49	49
Sp. gr. of enricher at temp. as used	0.814	0.803	0.858	0.877
Wt. of enricher used (lbs.)	0.05095	0.08683	0.09266	0.09471
Wt. of enricher per gal. (lbs.)	6.780	6.705	7.156	7.314
No. of gals. of enricher used	0.00759	0.01295	0.01294	0.01295
Wt. of finished gas per cu. ft. (lbs.)	0.0483	0.05031	0.04922	0.04941
Wt. of blue gas per cu. ft. (lbs.)	0.04096	0.04033	0.03902	0.03853
Total finished gas made, corrected (cu. ft.)	2.434	2.437	2.411	2.239
Total blue gas used, corrected (cu. ft.)	2.065	1.809	1.962	1.772
Wt. of finished gas made, corrected (cu. ft.)	0.11756	0.12260	0.11867	0.11063

Wt. of blue gas used, corrected (cu. ft.)	0.08458	0.07295	0.07656	0.06827
Wt. of tar recovered (lbs.)	0.00686	0.01903	0.02408	0.02360
Wt. of condensation collected (lbs.)	0.00071	0.00278	0.00230	0.00209
B. t. u. of blue gas per cu. ft. (calculated)	320	318	299	319
B. t. u. of finished gas per cu. ft. (calculated)	595	747	696	734
B. t. u. of finished gas per cu. ft. (by calorimeter)	572	715	677	718
B. t. u. of enricher per lb.	19,775	19,251	19,532	19,042
Naphthalene produced (lbs. per 10,000 cu. ft.)	0.12	0.59	0.21	0.08
Wt. of enricher not producing gas (includes tar, carbon, condensation) (lbs.)	0.01797	0.03718	0.05055	0.05235
Wt. of free carbon formed (lbs.)	0.01040	0.01537	0.02417	0.02666
Wt. of oil gas made (lbs.)	0.03298	0.04965	0.04211	0.04236
Oil gas made (cu. ft.)	0.369	0.628	0.449	0.467
Oil gas made per gal. of enricher (cu. ft.)	49.20	49.20	34.7	36.06
Enricher used per 1,000 cu. ft. of gas made (gals.)	3.081	5.31	5.11	5.784
Per cent. enricher producing oil gas	64.73	57.18	45.5	44.73
Per cent. enricher producing oil tar	13.46	21.91	25.9	24.92
Per cent. enricher producing carbon	20.41	17.70	26.1	28.14
Per cent. enricher condensing	1.39	3.21	2.5	2.21
Per cent of oil gas in total	15.16	25.77	18.62	20.85
Per cent. of blue gas in total	84.84	74.23	81.38	79.14
Total B. t. u. supplied by blue gas per cu. ft. finished gas.	271	236	243	252
Total B. t. u. supplied by oil gas per cu. ft. finished gas	324	511	453	482
Per cent. B. t. u. supplied by oil gas	54.45	68.40	65.08	65.67
Per cent. B. t. u. supplied by blue gas	45.55	31.60	34.92	34.33
Total B. t. u. per gal. of enricher	105,161	96,233	88,650	83,333
Total B. t. u. per lb. of enricher	15,489	14,352	12,390	11,393

Per cent. B. t. u. enricher transferred to finished gas.	78.27	74.55	63.43	58.78
Carbon produced per gal. of enricher (lbs.)	1.387	1.179	1.867	2.059
Carbon produced per gal. of enricher per per cent. asphalt present (lbs.)......	0.6935	0.09825	0.0491	0.05148
Naphthalene produced per gal. of enricher (lbs.)	0.00389	0.01111	0.0041	0.00138
Naphthalene produced per gal. of enricher per per cent. asphalt present (lbs.)	0.00195	0.00093	0.000108	0.0000345

SAMPLE OILS NOS. 1, 2, 3, 4.—CRACKING UP TESTS AT 1,500° F. DATA AND RESULT SHEET.

Sample number	4	2	1	3
Sp. gr. at 60° F...............	0.831	0.821	0.872	0.892
Paraffine series oils, by acid test (per cent.)	98	88	62	60
Asphalt series oils, by acid test (per cent.)	2	12	38	40
Flash point (deg. F.)	230	100	192	—
Temp. of carbureter (deg. F.)	1,500	1,500	1,500	1,500
Temp of blue gas used (meter outlet) (deg. F.)	77	79	87	84
Temp. of finished gas made (meter outlet) (deg. F.)..	77	79	86	80
Barometer (in.)	29.37	29.34	29.2	29.3
Temp. of gas oil (deg. F.).....	101	107	118.5	105
Duration of test (min.).......	31	22	17	31
Enricher used (cc.)	35	49	23.4	49
Sp. gr. of enricher at temp. as used	0.816	0.804	0.851	0.876
Wt. of enricher used (lbs.)...	0.06295	0.08683	0.04395	0.09400
Wt. of enricher per gal. (lbs.)	6.805	6.705	7.097	7.306
No. of gals. of enricher used..	0.00925	0.01295	0.00619	0.01294
Wt. of finished gas per cu. ft. (lbs.)	0.05041	0.04919	0.04644	0.04961
Wt. of blue gas per cu. ft. (lbs.)	0.04374	0.04020	0.04056	0.03963
Total finished gas made, corrected (cu. ft.)	2.342	2.520	1.482	2.430
Total blue gas used, corrected (cu. ft.)	1.828	1.830	1.207	1.913

Wt. of finished gas made, corrected (lbs.)	0.11806	0.12396	0.06882	0.12055
Wt. of blue gas used, corrected (lbs.)	0.07996	0.07357	0.04895	0.07581
Wt. of tar recovered (lbs.)	0.00814	0.01918	0.00977	0.02150
Wt. of condensation collected (lbs.)	0.00130	0.00313	0.00089	0.00171
B. t. u. of blue gas per cu. ft. (calculated)	291	307	297	333
B. t. u. of finished gas per cu. ft. (calculated)	651	694	574	720
B. t. u. of finished gas per cu. ft. (by calorimeter)	—	677	—	697
B. t. u. of enricher per lb.	19,775	19,251	19,532	19,042
Naphthalene produced (lbs. per 10,000 cu. ft.)	—	0.46	0.14	0.43
Wt. of enricher not producing gas (includes tar, carbon, condensation) (lbs.)	0.02485	0.03644	0.02408	0.04986
Wt. of free carbon formed (lbs.)	0.01541	0.01413	0.01342	0.02665
Wt. of oil gas made (lbs.)	0.03810	0.05039	0.01987	0.04474
Oil gas made (cu. ft.)	0.514	0.690	0.275	0.517
Oil gas made per gal. of enricher (cu. ft.)	54.49	53.2	44.42	39.94
Enricher used per 1,000 cu. ft. of gas made (gals.)	3.949	5.14	4.109	5.32
Per cent. enricher producing oil gas	60.52	58.0	45.21	47.29
Per cent. enricher producing tar	12.93	22.0	22.23	22.72
Per cent. enricher producing carbon	24.48	16.2	30.53	28.17
Per cent. enricher condensing	2.07	3.60	2.03	1.50
Per cent. of oil gas in total	21.95	27.3	18.55	21.27
Per cent. of blue gas in total	78.05	72.6	81.45	78.72
Total B. t. u. supplied by blue gas per cu. ft. finished gas.	227	222	242	262
Total B. t. u. supplied by oil gas per cu. ft. finished gas	424	472	332	458
Per cent. B. t. u. supplied by oil gas	65.13	67.89	57.83	63.61
Per cent. B. t. u. supplied by blue gas	34.87	32.11	42.17	36.39

Total B. t. u. supplied per gal. of enricher	107,368	91,828	80,798	86,090
Total B. t. u. supplied per lb. of enricher	15,777	13,695	11,385	11,783
Per cent. B. t. u. in enricher transferred to finished gas	79.78	71.14	58.28	61.87
Carbon produced per gal. of enricher (lbs.)	1.666	1.091	2.168	2.059
Carbon produced per gal. of enricher per per cent. asphalt present (lbs.)	0.833	0.0909	0.05705	0.0514
Naphthalene produced per gal. of enricher (lbs.)	——	0.0089	0.00341	0.0080
Naphthalene produced per gal. of enricher per per cent. asphalt present (lbs.)	——	0.00074	0.000089	0.0002

THE CHAIRMAN: Mr. Weisser wired some corrections relating to two clerical errors, which should have been corrected in the printed copy which was distributed prior to the meeting. We received Mr. Weisser's message too late, however, to have the corrections made on the sample calculation sheet. The paper is now open for discussion.

MR. O. B. EVANS (Philadelphia): The change from the excellent gas oils of the past to those of indifferent character of the present seems to have been a rapid one. With the increasing demand for motor oils, it is not at all improbable that in the very near future a much higher percentage of the crude oil will be converted into this more valuable product than at present. There will remain for the gas industry then only such residues as cannot be otherwise utilized.

It is unfortunate that we do not know more regarding the phenomena of oil cracking in a water-gas machine. Oils are still purchased upon distillation specifications which give only the roughest idea of their value. Only recently have we been able to tell the oil refiner even approximately the kind of oil best suited to our needs, and the relative value to us of the various products which he may have to offer is only known after actual trial. Unquestionably, the oil which we will be compelled to use in the future will, according to our present standard, become poorer each year, and if we are to maintain our present efficiencies we must make a more scientific study of our raw materials.

It is gratifying to discover that a number of gas companies have already installed laboratory water gas sets. In skilled hands these miniature sets are so absolutely under control, and respond to changes in operation so much more readily than do even small size commercial apparatus, that it seems unfortunate that we have waited so long before availing ourselves of their usefulness.

Mr. Weisser is the first to present to the Institute the result of experimentation upon small apparatus, and it is to be hoped that his excellent paper will so stimulate interest in this line of work that we may expect similar contributions each year.

Somewhat over three years ago the company with which I am connected installed a combination gas and electrically-heated laboratory set for a comprehensive study of gas oils. During this time we have altogether experimented upon somewhat over 60 oils from various fields, running from a Pennsylvania Northern oil to a Mexican asphaltic base oil. Eight of these oils, which varied in candles per gallon produced from between 1½ to 6½, were simultaneously run on the laboratory set and upon the 6-foot experimental carbureted water gas set, and it was found that there was a definite relation between the results obtained on the two pieces of apparatus. We have therefore felt that from the results on the laboratory set we could predict within very narrow limits the results to be expected in commercial operation.

Mr. Weisser states that the quantity of carbon found in the cracking of oil is independent of the temperature and depends upon the quantity of asphaltic hydrocarbons present. He then calculates that an oil which upon cracking forms more than 20 per cent. of carbon cannot be used in a water gas set. By deduction from chart 5, therefore, any oil containing more than about 12 per cent. of asphaltic material would be unfit for use.

I agree with part of this statement and would hesitate to use an oil which formed over 10 per cent. of carbon. If Mr. Weisser had been able to run his apparatus for a sufficient length of time to produce an appreciable quantity of carbon, I think he would find that the amount actually made was directly dependent upon the heats carried, and that for a given temperature was almost in proportion to the quantity of coke residue by a laboratory distillation of the oil.

Mr. Weisser also intimates that the material soluble in sulphuric acid is asphaltic, and that which is insoluble is paraffine. I am not sure this is strictly the case. However, we have for several years used successfully an oil containing 56 per cent. of paraffines and which, therefore, according to Mr. Weisser's assumption, should presumably contain 44 per cent. of asphaltic. With this oil we have obtained a candle efficiency of nearly 6 candles per gallon and a heat transfer to the gas of 95,000 B. t. u. per gallon.

In connection with the results given by Mr. Weisser, it may be interesting to quote some figures obtained on our miniature set.

In general, a gallon of oil contains approximately 135,000 B. t. u. In a number of oils ranging from a paraffine base Northern, which according to Mr. Weisser's analysis would contain (as nearly as can be estimated) about 10 per cent. of material soluble in sulphuric acid, to an asphaltic base oil containing, on the same basis, 51 per cent. of soluble material, the quantity of heat given up to the gas per gallon varied from 90,000 B. t. u. to 110,000 B. t. u. per gallon, representing a heat transfer efficiency of from 67 to 80 per cent. The quantity of oil gas produced per gallon of oil will increase with the fixing temperature, and at the most efficient temperature will vary with different oils from about 45 to 65 cubic feet per gallon, of which, roughly, 50 per cent. are fixed gases of the paraffine series, and the remainder classed as illuminants. The Bureau of Mines has made some very careful analyses of New York City gas and of carbureted water gas from Pittsburgh, and has shown that these illuminants contain about 80 per cent. of ethylene and propylene. It is hard to believe, however, that these figures represent the composition of illuminants of ordinary carbureted water gas, since by tar scrubbing at low temperatures it is possible to reduce a 26 candle-power water gas to 6 candle-power, and its heating value from 670 to 580 B. t. u. This excessive reduction in candle-power and comparatively slight reduction in heating value, would seem to indicate clearly that most of the illuminating value of a gas comes from the vapors contained in it and not from the fixed gases.

While we recognize that there is no definite relation between the candle-power of a gas and its heating value, nevertheless, in general it has been found that of two oils, that giving the higher candles per gallon will give the higher heating value. For example, a Northern oil, on a 4-gallon per thousand basis giving a candle efficiency of 6.50, will transfer 110,000 B. t. u. per gallon of oil to the gas, yield 60 feet of oil gas per gallon, and produce a carbureted gas of 665 B. t. u. per cubic foot. A Southern oil, on the same basis, gives 4.00 candles per gallon, will transfer to the gas 90,000 B. t. u. per gallon of oil, yield 47 cubic feet of oil gas, and produce a carbureted gas of 585 B. t. u. per cubic foot. In other words, while the candles per gallon obtained from the two oils will vary more than 60 per cent., the heating value of the finished gas will only vary about 14 per cent.

The requirements of an oil for gas making purposes differ somewhat, depending upon whether the gas is made to a calorific standard or to a candle-power standard. While fortunately the candle-power standard is obsolescent, nevertheless there is still so much gas manufactured according to a candle-power standard that candle-power may not be entirely ignored.

Most gas oils contain the same complex series of hydrocarbons, but in varying proportions. They may be roughly divided into a saturated series represented by the paraffines, and an unsaturated series represented by the aromatics. In the presence of blue gas and under the action of heat the saturated series decompose into other members of the same or allied series, such as the aromatics, and tend to form the tars.

It is conceivable that two oils might produce the same quantity of aromatic vapors, the amount retained in the gas, however, might be very different because of the greater quantity of tars produced in the one case than in the other and the higher absorption of vapors by these tars. Most of the heating value obtained from oil gas comes from the fixed gases, while most of the illuminating value comes from the vapors. It is evident, therefore, that if we want to make a high heating value gas we endeavor to make as much of the fixed gas as possible, and if, on the other hand, we desire a high candle-power gas, we wish to retain in the gas the greatest quantity of the vapors.

Throughout our entire gas manufacturing system of mains, condensers, etc., the vapor in the gas is to a greater or less extent in contact with its liquid condensate. If the vapor pressure of the liquid condensate is greater than that of the vapor in the gas, the gas will pick up the liquid until the vapor pressures of the two are equal. The converse will take place if the vapor pressure of the liquid is less than that of the vapor.

The quantity of vapor that can be retained in the gas depends, therefore, somewhat upon the method of condensation, and upon the quantity and character of the tar made.

All of us probably have been confronted by unexplainable variations in oil results from day to day. It is very likely that in many such cases the character of the gas made in the apparatus was identical, but because of variations in treatment after leaving the apparatus, such as differences in condensing temperature, rate of flow, quantity of drip in the main, etc., the amount of light giving vapors retained may vary materially. In many works the ultimate effect of a change in gas oil or operating conditions, using the same oil, may not be felt for several weeks; this, of course, is due entirely to the necessity for saturating the system and bringing all materials into equilibrium. Probably many beneficial changes in operation have been discarded from the mere fact that after such changes were put into operation the efficiency of the apparatus immediately dropped off. Had such method of operating been continued for a sufficient length of time, it is easily conceivable that after equilibrium had been attained the operating results would have been materially benefitted.

What is true on a large set is true to the same extent on a laboratory set. Since the time necessary for establishing equilibrium conditions is probably dependent upon the relation between the quantity of gas made and the size of the apparatus (mains, condensers, meters, holders, purifiers, etc.), and in general the size of the apparatus in a laboratory set is much greater in proportion to the quantity of gases made than it is on a commercial set, we would hardly expect to obtain conditions of equilibrium on a small set any quicker than we would on a commercial set. The one reason, however, why we are able to obtain quicker results on a laboratory set is the ease with which we are enabled to control our conditions; nevertheless I firmly believe that it is impossible so to design a laboratory set which will give accurate results inside of 10 hours. It has been our practice to continue each test for about 14 hours, from 4 to 6 of which are required to produce equilibrium after the set has been brought up to operating conditions. The remaining time is given up to the securing of a satisfactory series of average readings.

In conclusion, I cannot emphasize too strongly the beneficial results that can be obtained by the proper use of a laboratory size set, not only for research on oils but for determining the probable behavior of an oil from a small size sample. I do not want you to leave here, however, with the idea that it is a very simple matter to stick up a 2-inch pipe and heat it, feed it with blue gas and oil, and expect to get results. I believe this work has to be done by trained men after considerable experience, the design of the installation, and particularly of the scrubbing apparatus, must be very carefully thought out, the obtaining of results is not a matter of minutes, but of hours, and any attempt to shorten the length of the test is very likely to result disastrously.

Mr. R. C. Downing (Chicago): This paper has been of much interest to me, since I have been engaged in similar lines of work for the last two years in the Peoples Gas Light and Coke Company laboratories here in Chicago. The cracking test, as described, is in my opinion the most reliable means of determining the value of gas oils for use in water gas manufacture.

And in connection with what Mr. Evans said, I have been noticing also the way in which the cracking test has compared with the oil as used in the machine, and the results have agreed very closely, within less than 5 per cent. almost at all times.

Enormous and constantly increasing demands for gasoline have resulted in great changes and developments in the oil refining business. New processes have been put into operation, all of which have the objective of increasing the production of gasoline. Chief among these are the Burton pressure still and the aluminum chloride treatment of Mr. McAffee. Either one results in a much greater yield of gasoline from the crude oil, at the expense of what was formerly the gas oil fraction. While all gas oils have not deteriorated, a decrease in the quality or illuminating value of same has been noted during the last two years which has amounted to 15 per cent. Going back 10 years or more the quality has decreased as much as 25 per cent., while the price has at least doubled. These facts speak for themselves and illustrate the necessity for the gas manufacturer knowing what kind of oil he is buying before it is actually used in machines.

I would like to ask Mr. Weisser just what kind of oils these were that he has tested. I mean the field from which they were obtained. The gravities are 40°, 38°, 30° and 27° Baumé, respectively. In my estimation such oils should give good results in a gas machine. Oils with as low a gravity as 27 have yielded excellent results in practice, their only drawback being that they produce more carbon in the checkerbricks. However, with many companies the cost of oil amounts from one-half to three-quarters of the total manufacturing cost. This being the case, it is cheaper to use an oil which produces carbon and still gives good results, since labor is cheaper than oil.

Mr. Weisser has stated that an oil with more than 20 to 25 per cent. of unsaturated compounds will cause trouble. I am inclined to think his estimate is a trifle low. I would like to inquire if he has based his conclusions on the results of the laboratory cracking tests, or from the actual behavior of the oil in gas machines. The percentages of carbon given in the paper are about 10 per cent. higher than those obtained in the Peoples Gas Light & Coke Company laboratory. This is, no doubt, due to the fact that Mr. Weisser has calculated his specific gravities, while we obtained them with the Schillings apparatus. If he has assumed the illuminants to be ethylene, which I presume he has, from an examination of his calculations, the amount of gas made will be low and the carbon high. The actual specific gravity of the illuminants of carbureted water gas is much nearer to that of propylene. Furthermore, the specific gravity of the illuminants changes considerably between the temperatures 1,300° and 1,500° F.

Another factor which contributes to rather inconsistent results if not considered, is the time of contact of the oil vapors in the machine. Most gas machines are designed so that the time of contact of the gas in the checkerbrick is from 2 to 4 seconds. Mr. Weisser has operated his experimental machine so that the time of contact has averaged 15 seconds, with a minimum of 8 and a maximum of 23 seconds. I believe more reliance could be placed on his results had he sought to maintain a constant time of contact for all readings, and reduced that time to approximately 4 seconds.

An examination of the data sheet will show that the author has neglected to consider the effect of concentration. The oil in-put (used) varies from 3 to 6 gallons per thousand. This will alter the amount of tar and carbon obtained to the extent of a few per cent.

The high amount of carbon dioxide in the blue gas used will also have a tendency to produce more carbon. The wide differences in the analysis of the various samples used will again contribute to variations in results.

It is rather disappointing that no definite conclusions were arrived at concerning naphthalene formation. It has occurred to me that the relation between asphaltic compounds and naphthalene may exist, but was perhaps obscured by a disregard of the time and concentration factors mentioned. One is rather surprised that the naphthalene produced does not increase at higher temperatures. This appears contrary to all previous experience.

A point to be cleared up in connection with the production of naphthalene is the relation between such production and the percentage of aromatic compounds present. All authorities agree that the steps in the thermal decomposition of an oil proceed from higher paraffines to lower paraffines—olefins, acetylene, benzene and homologues, diphenyl, naphthalene, anthracene, carbon and gas. It is, therefore, reasonable to believe that a larger percentage of any aromatic compounds in an oil will lead to the production of more naphthalene.

The question also has arisen in my mind as to why the calculated B. t. u. of the finished gas was used in computing the B t. u. per gallon, instead of the calorimeter value. On the whole the B. t. u. per gallon result as obtained by the cracking test is very reliable and for all around purposes gives the most information of value concerning the oils. It is my belief that the B. t. u. per gallon of oil No. 4, containing 98 per cent. of paraffine compounds, is not as great as has been stated in the paper; that is, when figured correctly, because this oil was run with a much lower oil rate per thousand.

My own conclusions regarding gas oils have been that there is no definite relation existing between the percentage of unsaturated compounds and the gas making value. The opinion I hold is that either more tar or carbon will be formed as the unsaturated compounds increase, but I have not as yet made a sufficient study of this phase of the question to set a limit on the amount of unsaturated compounds permissible in oils for use in manufacturing carbureted water gas.

I trust that Mr. Weisser will not be discouraged by the few criticisms I have made of his paper. I realize the difficulties he has labored under. On the whole I believe that his work has been a development in the control of water gas manufacture and it would be advantageous for more chemists to devote their attention to this line.

Regarding what Mr. Evans has said concerning the equilibrium conditions which he failed to reach in his apparatus in our machine in the laboratory, the machine can be started in the morning and inside of 2 hours it is up to the temperature to operate, and we find no difficulty in getting equilibrium conditions. The first cubic foot of gas we make is just as good as the last three or four. Furthermore, we have used the cotton scrubber. I understand that Mr. Evans is using a much bulkier scrubber than we are using, which contains sand and is cooled to 350° F., and I believe he scrubs the gas more thoroughly. That may have something to do with the trouble that he has in getting equilibrium conditions.

MR. J. W. BATTEN: Mr. Chairman, Mr. Worthing, our chemist, has prepared a discussion of this paper, which I will present.

MR. LEIGH E. WORTHING (Detroit) (Written discussion communicated): Mr. Weisser's paper is a valuable contribution to the technology of a process that is too little understood. It is only through efforts like his that the manufacture of water gas will be put upon a scientific basis. Especial credit should be given him from the industry with which he has compiled an immense amount of data from these tests.

I would like, however, to ask Mr. Weisser what he means by asphalt basic oils. The test by which he determines the amount of asphalt basic oil present is also a test for unsaturated compounds. Slop-tank oil, which is what the unfortunate water-gas maker gets nowadays, consists largely of oils which have undergone some kind of cracking process. It contains an appreciable amount of unsaturated compounds. Tests on our oil show 15 per cent. or more of these. Do these unsaturated compounds have the same influence on the gas making qualities of the oil that asphalt basic oil does?

Mr. Weisser concludes from 12 tests that the temperature of the carburetor has no effect upon the amount of oil going to carbon. Mr. Weisser will have to adduce more proof than he has so far brought forward to convince the average water gas superintendent that the formation of carbon and naphthalene are not in some degree functions of the temperature.

From a few experiments with somewhat similar apparatus, we have come to the conclusion that it is hopeless to get concordant results on tar, condensate, and carbon. The difficulties in the way of making a separation of tar, condensate, and carbon are so great that the necessary errors are larger than the differences due to temperature, or quality of oil. This in spite of the fact that we used 100 cubic centimeters of oil against Mr. Weisser's maximum of 49.

I have read only an abstract of the paper by Mr. Downing, which Mr. Weisser mentions. It would seem, however, that the method of cracking oil in an atmosphere of blue gas is novel, and possibly an advance on Mr. Downing's method. Some experiments should be undertaken to determine the effect of this, as compared with the method used by Mr. Downing, and to determine whether the results obtained are valuable enough to compensate for the complication of the apparatus. One outstanding feature of Mr. Weisser's results is his low gas yield, as compared with that obtained by Mr. Downing. For all classes of oil, his yield at 1,400° F. is 40.2, as against an average of 66.0—taken from the curve included in the abstract of Mr. Downing's paper published in the *Gas Record,* Vol. IX, No. 6, page 218. The effect of an atmosphere of methane on the production of oil gas was discussed some time ago by Mr. Jones, in a paper read before the Pacific Coast Gas Association. This effect was distinctly favorable. It would seem, in this connection, that in order to get concordant results with this method, the oil per thousand

OIL EFFICIENCIES RE-CALCULATED AND CORRECTED FROM MR. WEISSER'S DATA.

							October 16, 1915		
No.	Per cent. asphalt base	B. t. u. from finished gas per pound enricher	% B. t. u. of enricher in finished gas	Temp.	Temp.	Effic. 2% asphalt base oil	Effic. 12% asphalt base oil	Effic. 38% asphalt base oil	Effic. 40% asphalt base oil
4	2.0	16,450	83.2	1,300	1,300	83.2	64.7	62.7	59.8
4	2.0	14,320	72.4	1,400	1,400	72.4	69.7	58.7	57.8
4	2.0	15,670	79.3	1,500	1,500	79.3	59.3	57.5	58.7
2	12.0	12,440	64.7	1,300		79.3			
2	12.0	13,430	69.7	1,400					
2	12.0	11,410	59.3	1,500					
1	38.0	12,300	62.7	1,300					
1	38.0	11,450	58.7	1,400					
1	38.0	11,230	57.5	1,500					
3	40.0	11,400	59.8	1,300					
3	40.0	11,030	37.8	1,400					
3	40.0	11,180	58.7	1,500					
Average for all temperatures:									
	2%	15,480	78.3						
	12%	12,430	64.6						
	38%	11,660	59.6						
	40%	11,200	58.8						

COMPARATIVE TABLE OF THE MORE IMPORTANT FACTORS IN MR. WEISSER'S TESTS.

No.	Oil per cent. asphalt base	c. f. oil gas per gallon oil	Gals. of enricher per "M" cu. ft.	B. t. u. furnished per lb. enrich.	% B. t. u. of enricher in finished gas	% of enricher producing gas	% of enricher producing tar	% of enricher producing carbon	% of enricher producing condensate	Temp.
1	38	40.31	3.715	4,500	23.04	43.67	24.39	30.41	1.53	1,300
1	38	34.70	5.110	4,284	21.90	45.50	25.90	26.10	2.50	1,400
1	38	44.42	4.109	6,303	32.20	45.21	22.23	30.53	2.03	1,500
2	12	47.5	5.74	4,514	23.40	54.20	23.90	18.20	3.50	1,300
2	12	40.8	5.31	4,940	25.66	57.18	21.91	17.70	3.21	1,400
2	12	53.2	5.14	4,460	23.18	58.00	22.00	16.20	3.60	1,500
3	40	41.0	5.051	3,691	19.38	43.89	23.61	29.66	2.84	1,300
3	40	36.06	5.784	4,382	23.01	44.73	25.92	28.14	2.21	1,400
3	40	39.94	5.32	4,090	21.50	47.29	22.72	28.17	1.80	1,500
4	2	43.47	2.77	6,388	32.34	67.89	8.73	18.95	4.43	1,300
4	2	49.20	3.081	5,397	26.79	64.73	13.46	20.41	1.39	1,400
4	2	54.49	3.940	5,242	26.51	60.52	12.03	24.48	2.07	1,500

should be kept within reasonably narrow limits. In Mr. Weisser's tests it varies from 2.77 to 5.74.

Mr. Weisser seems to conclude that the limiting condition in the use of any gas oil is the amount of carbon which can be taken care of by the carburetor blast. Of course, there is no limit, other than a practical one, on the amount of oil going to carbon which can be taken care of in the water gas machine. The factor which will determine the use of any oil is its B. t. u. efficiency, divided by the price per gallon. If an oil has a 60 per cent. efficiency and costs 4 cents per gallon, and another oil has 70 per cent. efficiency and costs 5 cents per gallon, we are going to use the 4-cent oil.

MR. A. E. FORSTALL: Mr. Chairman, Mr. Evans left one point uncertain in his remarks. He gave the amount of heat transferred to the gas from the oil as varying from 90,000 to 110,000 B. t. u. per gallon, and then he went on to say that the amount of heat increased with the amount of fixed gas, but he did not say whether he was working for calorific value or for candle-power when he obtained these results.

MR. O. B. EVANS (Philadelphia): Our method of determining the value of a gas oil is to subject a sample of this oil to various fixing temperatures, and to determine separately the candle-power and calorific results obtained at each individual temperature. In general, the experiments are made at four different temperatures 75° apart. The rate of oil admission, the character of the blue gas, and the quantity of gas flowing through the apparatus is maintained constant throughout the various tests, so that the difference in results obtained is due entirely to a variation in the fixing temperature. The figures previously quoted are the best obtainable upon the different oils when tested in this manner.

MR. L. S. WILLIAMS (Harrisburg, Pa.): I would like to ask if in making these tests it would make any material difference if water and coal gas would be used instead of blue gas to sweep the oil gas out of the carburetor? And also if there is any basis of figuring oil efficiency on a B. t. u. basis?

Mr. R. G. Griswold (New York): This subject of the study of oils for water gas making, deserves a good deal of attention.

In looking over Mr. Weisser's paper, one notes that there was no water vapor present during the cracking of his oils. I believe that if water vapor had been used the conditions would have approached more nearly the conditions which obtain in a water gas machine. It is well known that with the most careful control some water vapor passes through the fuel bed without decomposition, and this water vapor would naturally have at least some effect on any carbon previously deposited or in the state of being deposited from decomposition of the oil.

It is true that the effect of water vapor is eliminated from all of the oils Mr. Weisser tested, but this does not necessarily mean that the effect of water vapor would be the same in each case. I personally believe that Mr. Weisser's most serious mistake was in not adding a little water vapor. On the other hand, his analysis shows very painstaking effort and he deserves credit for it.

The Chairman: Mr. Weisser, will you conclude the discussion, please?

Mr. F. L. Weisser (San Antonio, Tex.): The kind of gas oil that was used in these experiments was mostly Texas oil. Some of it was Oklahoma oil. I do not know whether any of the Texas or Oklahoma gas oils are used to any extent in this part of the country for gas making. At any rate it has been our experience with some of these Texas oils that the carburetor begins to stop up very rapidly. So far as the acid test goes, in order to determine the amount of asphaltum present, these are not absolutely reliable; however, so far as comparative values go it is reasonable to assume that the asphaltum will behave alike in all cases, and therefore it will serve as a means of comparing one oil with another. It has been our experience that whenever the gas oil contains more than 25 per cent. of asphalt basic oil it will carbonize very rapidly in the checkerbrick. The effect of which will very often be noticed after the machine has been in operation for 350 to 400 hours. We have had machines in operation until the carburetor was almost completely stopped up and then we have had as much as 500 hours of operation.

As far as the production of naphthalene is concerned it must not be understood that this has no bearing on the temperature. The conditions are such that when gas oil is used which carbonizes very rapidly the carburetor becomes unevenly heated; the temperature being too low in some places and too high in others, and for this reason an excessive amount of naphthalene will be produced on account of the local high temperatures.

By asphalt basic oil is meant that portion of the oil which combines with the sulphuric acid.

Referring to the B. t. u. per gallon of enricher, I will say that by dividing the total B. t. u. supplied by the oil gas per cubic foot of finished gas, by the amount of oil gas used per cubic foot of finished gas, you will find that the results will agree very closely with those that have been mentioned.

THE CHAIRMAN: I wish to thank Mr. Weisser for his valuable contribution and for the great amount of work which he has given to this paper.

We will now listen to an illustrated talk on a coke oven plant.

MR. C. J. RAMSBURG (Pittsburgh, Pa.): When we were asked to get up a paper connected with the by-product coke-oven industry and its relation to the gas business, we went over a good many subjects that we might put into this paper, but it seemed to me that the bulk of the men in the gas business had never had an opportunity to see a by-product coke gas plant, and that the best thing we could get up would be a moving picture of a modern plant, and so I shall ask you all to come along with us and take a look at one, so I beg your indulgence in regard to both the picture and myself.

A moving picture trip to the coke oven gas plant of the Laclede Gas Light Company, St. Louis, Mo., was then taken, personally conducted by Mr. Ramsburg.

THE CHAIRMAN: Mr. Ramsburg, we are very much indebted to you for your very interesting and entertaining lecture.

Gentlemen, we have two more papers and we will take those up to-morrow morning. One, the report of the Committee on Standard Tests, is quite an important one, and I hope that everybody will he here. It has been referred to a great many times to-day, particularly in the carbonization report. We will now adjourn until 9.30 to-morrow morning.

Thereupon the meeting was adjourned until 9.30 o'clock A. M., Wednesday, October 18, 1916.

ACCOUNTING SECTION.

First Session, Tuesday 2:30 P. M., October 17.

MR. J. P. CROWLEY, *Vice-President*, Chairman.
MR. HENRY HARMAN, *Secretary*.

THE CHAIRMAN: The meeting will please come to order.

It gives me great pleasure to welcome you to the opening session of the Accounting Section.

Before proceeding with the work arranged for our consideration, I desire to acknowledge with thanks and to express my appreciation of the hearty support and cordial co-operation given me by our President, the officers of the Institute and the Chairman and members of the Technical Committee in promoting the work of the Accounting Section.

Acknowledgement is also made to those who have contributed so generously of their time in the preparation of papers and written discussions for our program. We also desire to extend our thanks to the Chairman and members of the Committee on Arrangements for providing for our comfort and convenience while attending the sessions.

The papers presented for your consideration are contributed by capable authors and cover practical subjects that should interest all of our companies. In submitting our program I am confident you will be convinced that our sessions merit a large attendance and that you will feel amply repaid for the time spent at our meetings. I, therefore, extend to all a most cordial invitation to attend all of our sessions. Your presence and participation in the proceedings will be an evidence to those who have contributed to our program that their efforts have resulted in mutual benefit and will be their recompense for the valuable time spent on the work.

The necessity for a good system of imparting instruction to company employees, clearly defining the policy of the management, and setting forth the proper procedure that should be followed in the performance of their duties is, it occurs to me, a subject of importance deserving of your careful consideration. I think we all appreciate that a well instructed staff of courteous, painstaking employees is essential if we are to secure efficiency in operation and obtain best results.

The desirability for a progressive and workable credit system for a company that aims to secure and to retain the good will of the public and at the same time develop its business to the fullest extent is most important. The good will of the applicant for service should, therefore, be secured at the start if we are alert to the necessity for acquiring a valuable asset.

We have on our program papers dealing with the subjects referred to, also papers on other important subjects, which I commend to your considerate attention.

The spirit of co-operation displayed by the other Sections of the Institute with the work of the Accounting Section has been most gratifying. The growth of our business during the past year and the possibilities of future development will bring up new and important problems that open up a wide field requiring our serious attention. I feel that we have only made a start this year and I look for great progress by our Section during the coming year under the guidance of my successor for whom I bespeak the same spirit of co-operation that I have received. The first paper on our program is by Mr. Charles S. Ritter, entitled "The Bulletin System as a Means of Instructing Employees." Mr. Ritter was unable to be present.

(The Secretary read the paper, as follows:)

THE BULLETIN SYSTEM AS A MEANS OF INSTRUCTING EMPLOYEES.

It probably is safe to assume that others besides the company I represent have experienced difficulty in presenting to their employees the policy of the management and details of their business in an effective manner. Whether there is a "one best way" or not I do not pretend to know, but the one most commonly used certainly falls very short of an ideal solution. I refer to verbal instructions and the common custom of placing a new employee in a strange place and allowing him to just drift along and pick up what he can, somewhat on the principle of "root hog or die."

The large general meetings of employees presided over by various employees and heads of departments, who indulge in the much overworked "pep talk," is also an inefficient system. Such meetings do bring employees together for a nice social time and thus foster loyalty and good feeling toward the company and each other, but it is not the time to press upon their attention important matters relating to the technique of our business. At such times the employee's attention is more likely to react on suggestions social than those of a business nature. There is also the danger that the speakers may be misunderstood. Although what they say may be expressed only as their own opinions, the fact that they are permitted by the management to address employees carries with it the appearance of having official sanction.

These meetings and smaller departmental meetings have important educational functions, however, and may be used to advantage as auxiliary to any good form of written information and instructions that may be adopted. As the principal means of carrying the policy and details of the gas business to employees they are inefficient, if not dangerous.

Printed books of instructions are inadequate because some of the rules they contain usually become obsolete before the ink with which they are printed gets dry. We could hardly afford to put out a new edition every time a change in business practice is made. A book of such rules that could stand any length of time without revision would be too limited in scope and too general in character to cover much of our business.

Another serious objection to such books is that they are almost never read. The minute details of our business cannot be forced on employees in chunks that large and when they are read it is generally in a perfunctory manner and for want of interest very little of the matter they contain is remembered.

The employees of a small company usually get most of their knowledge of the business by personal contact with the officers and its heads of departments with more or less good results, but as the company grows and employees increase, personal contact becomes less and less efficient until it almost disappears as an educating factor. The business gets more complex, new departments spring up and employees specialize more. When a department is divided the several branches progress in diverging lines and become widely separated, although their functions still bear a relationship to each other that must be maintained.

To standardize and co-ordinate the functions of departments and the duties and authority of employees so as to maintain cohesion and prevent confusion, duplication of effort and work at cross purposes is a big problem of itself. But when this is once accomplished we must still find an effective means of perpetuating the information and instructions evolved and of communicating them to all employees affected.

The psychological time to get the attention of employees and impress them with such information is when the subject matter presented is pertinent to the conditions at hand; that is, when it is "pat." It is the only time to get a good quality of attention. They should learn about "freeze offs" in winter when they are having experience with the trouble. That is the time the subject is given most intense consideration. It is the logical time at which to standardize shop and office practice and define the proper attitude of the company toward the consumers affected. The instructions prepared then should become a matter of record to be preserved in such a form that the next time the same trouble occurs they may be re-used. If we have before us a record of the methods adopted at a previous experience it will take but a short time to "bone up" on them, whereas we might have to repeat much of the experimental work formerly done to reach the same decision again. Whatever system is used for this purpose it must be flexible enough so that rules can be amended or cancelled on very short notice.

The bulletin system augmented by departmental meetings as used by us seems to answer the purpose very well. It was evolved from several similar methods and as a comprehensive system it has been a steady growth consisting of bulletins issued from time to time as the policy of the company became crystallized and the operations were standardized or revised.

My purpose is to describe the system and give the reasons for its adoption; the bulletins submitted are samples only and not intended as models for any other company, although anyone is welcome to whatever he may get from them.

If we should have an epidemic of stopped service and house pipes, the heads of departments affected would get together and work out a method for taking care of it. The complaints received, orders issued, the proper attitude to assume toward the consumers affected and other relevant matters would be considered and a bulletin of instructions to employees and departments affected would be compiled and submitted to the general manager for approval. If approved, a copy of this bulletin would be sent to the head of each department, who would receipt for it by signing the original copy. He would pass his copy around to each employee in his department to be read and signed. The original bulletin containing the receipts of heads of departments would then be returned to the office from which it was issued and the one signed by the employees to the head of the department in which they work. It would then be filed alphabetically according to subject in a loose leaf binder and held in the department for reference. It might be several years before a similar epidemic should occur and during which time we may have taken on many new employees or forgotten much of the detail of the former trouble, but when it does come again we simply refer to this bulletin and proceed accordingly. If there has been a change in the art of handling the trouble, the bulletin would be revised and redistributed. If, when the trouble occurs, we were obliged to again go over all of the detail used in arriving at the instructions it contained or if they were not a matter of record, much valuable time would be lost in getting started right, to say nothing about the confusion and duplication of the former work in formulating a plan of attack.

As far as the principles of the system are concerned, that is about all there is to it. There are a few things, however, that might be mentioned in connection with the distribution of the bulletins.

They should be made up on the standard letter size paper—8½ x 11 inches, punched for a loose leaf ring binder in which they can be filed alphabetically by subjects. These binders should be in the hands of all heads of departments and bulletins filed in them as they are issued. It is very important that they should be easy to refer to. Much of their success depends on proper classification and accessibility. The employees' signature on them will prevent the claim by them that they had never received the instructions given.

The bulletins may be initiated by such officers or heads of departments as are designated to do so, but they should be approved by the general manager or other executive officer in every case. The management is thus given an opportunity of knowing whether the policy of the company is being carried out correctly or not and the employees will know that the instructions given have received official sanction.

The following bulletins were selected from over 270 that have been issued in the course of ten years. They are submitted only to show the form in which they are gotten up and the variety of subject matter covered. In order to save space only the briefer ones were selected.

BULLETIN No. 1. (Third Revision.)

BULLETINS. April 2, 1915.

INSTRUCTIONS TO EMPLOYEES.

Instructions to office employees and others coming in contact with the office and the public are given by bulletins issued from time to time, as required.

They are handed to the heads of departments, *who will require employees under their supervision to read and sign them,* after which they will be retained for reference until cancelled or amended. They should be read by employees whether directly affected by the instructions they contain or not, so they may become generally informed on matters relating to our business.

If, for any reason, the instructions or rules contained therein become obsolete or inoperative, superintendents and office assistants shall notify the Secretary at once and bulletins will be revised or cancelled.

In the absence of specific instructions, an employee not knowing exactly how to proceed should refer the matter under consideration to the head of his department or to the next one higher in authority.

(Signed) CHAS. S. RITTER,
Secy. and Treas.

Approved: V. F. DEWEY,
Vice.Pres. and Gen. Mgr.

BULLETIN No. 2. (Third Revision.)

SECURITY FOR GAS BILLS. March 29, 1915.
CONSUMERS' DEPOSITS.

The ordinance under which we operate provides that "All applicants not in arrears for prior bills, owning or occupying premises on streets in which gas mains are laid, shall be supplied with gas." It is obvious, therefore, that being unable to choose our customers, we are obliged to enact such credit rules as will protect us from loss caused by misplacing confidence in irresponsible people.

New consumers, therefore, who are not property owners in good repute and whose responsibility cannot at once be determined, should be required to make a deposit large enough to secure a three months' gas bill or furnish the personal guarantee of some responsible person, preferably his landlord.

Considerable tact will often be necessary to convince some consumers that no reflection is intended on their credit, but that the deposit rule is a necessary business rule, established after much deliberation and a great deal of experience, and one that is generally recognized and enforced by all Public Service Corporations.

The question will often be asked, "Is everybody required to make a deposit?" to which you should frankly admit that a deposit is not required of everybody, but that the option is given consumers of furnishing the personal guarantee of some responsible person. It should be explained, however, that we do not ask landlords to guarantee applications, but simply say we will accept such a guarantee in lieu of a deposit.

Our legal right to require a deposit has been fully determined by the unanimous opinion of the Supreme Court of this State in the case of Williams vs. Gas Company, reported in "No. 52 Michigan." The text of this decision is, in substance, that "A gas company is fully authorized to enact, for its own protection, such reasonable provisions and requirements for securing payments for gas consumed, as in its judgment, seems necessary. Such provisions may involve the requirement of a cash deposit, or other form of security, the character and extent of which, within reasonable limits, is entirely optional with the gas company."

Applicants may often give such satisfactory account of their commercial standing and business connections as to make them an entirely satisfactory risk; they may be known to the order clerk taking the application. In such instances no security should be required. A memorandum, however, should be made in the "Remarks" column on the application of such business connections, and referred to the Chief Order Clerk, or Credit Department, for approval.

There are some risks that are very bad. Particular care should be exercised in requesting security for saloons, boarding houses, restaurants, rooming houses and temporary business places. Usually their bills are high and their credit poor. The previous bills of tenants of such places should regulate, to a very large extent, the size of deposit required. The location of the premises should also be considered.

The following paragraphs, pertinent to the above, are extracted from a decision given by The Wisconsin State Railroad Commission, which supervises public service corporations in that State.

1. It may require of any patron the deposit of a reasonable sum of money as security for the prompt payment of bills when due. In determining the reasonableness of the amount thus to be deposited, the probable amount of indebtedness that may be incurred during the month or other stated period at the end of which bills are made out and rendered, is an important factor. No more than *a sum sufficient to furnish adequate security for the credit extended may be legally exacted.*

2. It may require satisfactory security to be furnished in lieu of such deposit.

3. It may allow a discount upon bills paid on or before a stated day, or exact a penalty for failure to make payments within a certain time.

4. For neglect or refusal on the part of any patron to comply with any of the legal rules and regulations established it may discontinue service to such patron.

(Signed) CHAS. S. RITTER,
Secy. and Treas.

Approved: V. F. DEWEY,
Vice-Pres. and Gen. Mgr.

BULLETIN No. 23. (Fourth Revision.)

NON-PAYMENT SHUT OFF ORDERS. February 17, 1915.

1. Are given on back of delinquent gas bills.

2. Must be examined by Assistant Treasurer, Secretary, Credit Man or Superintendent of Collection Department, who will withdraw bills marked "See Secretary" ("S. S.") and those for consumers who in their judgment should receive preferred attention. Consumers who are considered responsible or whose gas should not be shut off for one reason or another, will be reminded of their delinquency by the following form letter written by the Credit Man:

> It is our custom to examine all past due accounts each month before handing them to our collectors, in order that we may avoid the embarrassment caused by personal presentation or possibility of turning gas off for some of our responsible consumers.
>
> We were fortunate enough to catch the enclosed bill this month before it got to them and are taking this means of bringing it to your attention.
>
> ....
>
> *Credit Man.*

3. "Turn on" orders for gas that has been turned off for "non-payment" are executed *the same day as given* and bear the stamp "Non-payment" so that shop department will know them. They must be made out immediately when bill is paid, stamped by time stamp and sent to the shop at once.

4. Ten days after gas has been turned off for non-payment (unless bills have been paid in the meantime) meters will be investigated to learn whether or not consumer has turned gas on himself.

5. Cancel Bulletin No. 186.

(Signed) CHAS. S. RITTER,
Secy. and Treas.

Approved: V. F. DEWEY, (Signed)
Vice-Pres. and Gen. Mgr.

BULLETIN No. 32. (Fourth Revision.)

January 25, 1915.

NAMES ON APPLICATIONS AND CONTRACTS.

On applications, contracts, meter orders, etc., and wherever else a consumer's name is used on our records, it should be written out in full. If the consumer fails to sign his first name, it should be obtained and written on the contract. Besides obtaining the full name, particular care must be exercised to transcribe it correctly.

Employees observing incorrect names on our records will notify the head of the department under whose supervision the record is kept.

(Signed) Chas. S. Ritter,
Secy. and Treas.

Approved: V. F. Dewey, (Signed)
Vice-Pres. and Gen. Mgr.

BULLETIN No. 107. (Third Revision.)

November 23, 1914.

CLEARING HOUSE PIPING.

If the stoppage is of such a nature that it can be cleared by the use of a high pressure pump, the work will be done for $1.00, subject to the following conditions:

An order to have the pressure tank used shall be taken either by the Complaint Department, Order Department or the complaint man who finds the trouble. In any case, the consumer will sign the *Application to have house pipe blown out* on our regular blank provided for the purpose, and the work must not be done until the application is signed.

The same care in getting the right name correctly spelled should be used as with all other orders. Both names must be given, and, if consumer's signature is not plainly written, the employee taking the order should rewrite it.

(Signed) Chas. S. Ritter,
Secy. and Treas.

Approved: V. F. Dewey, (Signed)
Vice-Pres. and Gen. Mgr.

BULLETIN No. 128. (Second Revision.)

TURNING GAS OFF. January 25, 1915.

WHEN A METER MAY BE REMOVED OR GAS SHUT OFF.

1. When so ordered by the person in whose name the application for gas was made. Whether he is the person using the gas or not makes no difference; the gas was turned on on his order and may be ordered off by him at his will.

2. For neglect or refusal to pay gas bills. See Franchise, Section 9-1.

3. From vacant premises, unless subscriber wishes to have meter remain.

4. When gas is being used by some tenant other than the original one, and without original subscriber's knowledge or consent. But not until present tenant has been notified to make an application for the gas.

5. When we have positive evidence that consumer is trying to defraud the Company.

WHEN A METER MUST NOT BE REMOVED NOR GAS TURNED OFF.

1. A guarantor's meter must not be removed for an unpaid bill he may have guaranteed, except on approval of the Secretary or other officer of the Company.

2. For non-payment, before 8 A. M. or after 2 P. M.

3. For non-payment of gas bills, unless notice in writing is presented or mailed at least 24 hours before it is to be turned off.

4. For any other bill excepting a gas bill.

5. For any other gas bill excepting one contracted in the name of the consumer—thus:

A father, brother or wife's gas must not be turned off to enforce collection of a bill for gas used by a son, brother or husband, unless we have positive evidence, and witnesses to substantiate it, that the account was changed from one to another to avoid payment.

6. For non-payment when we know the consumer to be reliable and that back bill is collectible without turning gas off.

7. When the consumer's account is marked "See Secretary," unless the Secretary or other officer of the Company has authorized it to be turned off.

8. For a bill of less than $1.00 unless the consumer refuses to pay the account or it is a balance of long standing.

(Signed) CHAS S. RITTER,
Secy. and Treas.

Approved: V. F. DEWEY, (Signed)
Vice-Pres. and Gen. Mgr.

BULLETIN No. 162. (Revised.)

December 14, 1914.

COMPLAINTS—BAD BURNERS.

Complaint clerks will hand to the New Business Department a memorandum of all poor supply complaints returned by shop inspector in which the trouble is located in burners of lamps, ranges or other small appliances. The New Business Department has representatives whose business it is to make personal calls on consumers for the purpose of putting burners in good condition or installing new ones.

The Complaint Department will notify the consumer in writing as to the nature of the trouble and also that our man will call, and if burners are wanted, he will install them at list prices.

(Signed) CHAS S. RITTER,
Secy. and Treas.

Approved: V. F. DEWEY, (Signed)
Vice-Pres. and Gen. Mgr.

BULLETIN No. 174 (Second Revision.)

February 1, 1915.

CHRONIC POOR SUPPLY COMPLAINTS WHERE THE FAULT LIES IN CONSUMER'S PIPING.

It is the duty of the Gas Company to maintain the gas supply to the lot line, but beyond this point (excepting through the meter) it is not responsible for stoppages. Generally speaking, however, the piping will be cleared free by the Company unless the trouble becomes chronic, or the "Blow out wagon" is required. See Bulletin No. 107 on "Clearing Housepiping."

In order to reduce the number of chronic complaints where the trouble is clearly due to some fault in consumer's piping, they are taken care of as follows:

Whenever it is learned by the Complaint man on the job, the Shop Department or the Complaint Department, that a certain consumer's housepiping is the cause of numerous complaints, a report of the case is made on the back of the complaint blank. When the complaint blank with this information reaches the Complaint Department, a letter is written to the consumer informing him about the nature of the trouble and that this Company will be unable to take care of it in the future; that while we have given temporary relief, the trouble is sure to come again; that consumer should have his plumber make the necessary repairs or alterations; or, if he prefers, that the Gas Company will make the change, provided he will make application for it at the Order Department in our office, or with the special gas fitter whom it is occasionally our custom to send out during the winter months.

The Shop Department will then refuse to care for any future complaints due to this particular trouble.

(Signed) CHAS S. RITTER,
Secy. and Treas.

Approved: V. F. DEWEY, (Signed)
Vice-Pres. and Gen. Mgr.

BULLETIN No. 156. (First Revision.)

WATER HEATERS.

October 22, 1915.

DANGER WHEN NOT CONNECTED WITH FLUE.

Water heaters should always be connected with flue to carry off burned gas. If they are not so connected, or for any other reason burned gas is discharged from them into the house, they may cause serious illness and in extreme cases, where a house is poorly ventilated, even death may result.

Complaints of leak at water heater, bad odor, etc., are usually caused by lack of flue connection, or improperly connected flue pipes, the result being that a poisonous gas is discharged into the room.

Whatever may be the cause of the trouble, prompt action is necessary. The consumer should be notified at once by the inspector to have stove dealer or plumber make flue connection or remedy the trouble. Inspector must also notify Complaint Department at office on the regular complaint form—No. 23.

Employees of this Company having knowledge of water heaters in use not connected by flue, or from which bad odors are discharged, should report the fact on information slip to the head of the department in which they are employed. This slip should then be sent to Complaint Department where it will be properly cared for.

Complaint Department will then notify consumer in writing by a special letter prepared for that purpose.

Cancel Bulletin No. 155.

(Signed) CHAS. S. RITTER,
Secy. and Treas.

Approved: V. F. DEWEY, (Signed)
Vice-Pres. and Gen. Mgr.

BULLETIN No. 205. (Fifth Revision.)

November 21, 1914.

SERVICE RENEWALS.

Underground service pipe laid by us on consumer's property, in renewal or replacement of old service pipe, shall hereafter be paid for by the consumer or property owner on the basis of cost of labor, pipe, fittings and inspection. Orders for renewal or changes will be taken on the new "Application for Service Pipe Renewal" form (not the regular service application).

The piping from main to lot line is installed at the expense of the Gas Company in winter and summer.

The following explanation should be given to consumers who object to this charge. New services are installed at 15 cents per foot because we are under contract with the city to do so, but this contract does not require us to renew nor maintain them, so they are renewed at cost only. Like everything else of a mechanical nature they become inadequate to supply modern or increased demands or they wear out. The service pipes are not guaranteed when installed and we are under no moral obligation to maintain or renew them, not any more so than any other merchant who sells mechanical devices.

(Signed) CHAS. S. RITTER,
Secy. and Treas

Approved: V. F. DEWEY, (Signed)
Vice-Pres. and Gen. Mgr.

BULLETIN No. 218. (Revised.)

December 14, 1914.

CRITICISING FELLOW EMPLOYEES.

Employees are hereby instructed not to criticise in the presence of consumers or the public the work of other employees. This applies especially to those who have been sent to attend to a complaint or fix something that is out of order, following another employee who failed to make matters right.

Not only is it a discourtesy to a fellow employee, but in the estimate of the consumer it places the Company in a position of hiring incompetent help.

If work has been neglected or improperly done, the matter should be reported to the head of the department in charge of the careless employee and leave it to him and his judgment to do the criticising or disciplining.

(Signed) CHAS. S. RITTER,
Secy. and Treas.

Approved: V. F. DEWEY, (Signed)
Vice-Pres. and Gen. Mgr.

BULLETIN No. 222. (Second Revision.)

December 18, 1914.

APPLIANCE CONTRACTS.

The contracts for small gas appliances are taken in triplicate by the solicitors selling them, the triplicate being left with the consumer.

The duplicate copy is held in the files of the New Business Department.

The original is turned over to the Credit Department for credit approval and if satisfactory is handed to the Petty Ledger Department, where it is used as the ledger sheet for the consumer's account. If it does not meet the credit requirements it is turned back to the New Business Department for further attention.

Before the contracts are entered on the Day Book sheets they will be turned over to the Stenographic Department where bills for the first payments will be made out and mailed to the consumers.

The Petty Ledger Department will then place the payments due on these appliances on the consumer's gas bills each month.

When these gas bills are paid, the tellers will make out merchandise stubs for the amounts paid and scratch them from the gas bills. Those consumers who dispute the accounts should be referred to the New Business Department on the fourth floor for an investigation.

(Signed) CHAS. S. RITTER,
Secy. and Treas.

Approved: V. F. DEWEY,
Vice-Pres. and Gen. Mgr.

BULLETIN No. 240½. (Revised.)

December 9, 1915.

CORRESPONDENCE DEPARTMENT.

The Correspondence Department was organized for the purpose of increasing the efficiency of our stenographic work, improving and standardizing our letter writing and to promote the correct policy of our Company.

It is under the supervision of L. J. Meissner, Superintendent.

He will examine the letters written by the various departments for the purpose of determining whether they are creditably composed and in accord with the policy of the Company. Letters that do not reflect the policy of the management will either be referred to the head of the department from which they originate or to the Secretary or his assistant.

(Signed) CHAS. S. RITTER,
Secy. and Treas.

Approved: V. F. DEWEY, (Signed)
Vice-Pres. and Gen. Mgr.

BULLETIN No. 247.

November 23, 1914.

SERVICE PIPE:
RELEASE WHEN BLOWN OUT.

A service pipe will not be "blown out" by a pressure tank unless the consumer, or all of the consumers supplied by it, will agree to release the Gas Company from all responsibility of completely stopping it up. The regular form of "Application to Clear Service Pipe," which contains an agreement to release this Company from all liability for damages which may result therefrom. will be signed *before* the work is done. It will be turned in to the office along with the poor supply complaint from which it originated and will be filed with it in the complaint file.

(Signed) CHAS. S. RITTER,
Secy. and Treas.

Approved: V. F. DEWEY, (Signed)
Vice-Pres. and Gen. Mgr.

BULLETIN No. 261. (Revised.)

January 18, 1916.

CASH COLLECTED.

All money collected on behalf of this Company by collectors, tellers, teamsters, solicitors or other employees, must be turned in to the Cashier on the same day it is collected, except as follows:

Cashiers at Stations "A" and "B" will make up their cash reports daily and turn them in to the Cashier at the Main Office before 1 P. M. on the first business day succeeding the one on which cash was received.

Cash received at the Delray and Wyandotte offices will be deposited in the bank on the first business day succeeding the one on which it was received. A duplicate deposit receipt will be taken and handed to the Cashier at the Main Office on the same day the deposit is made.

Cash collected by employees who do not report at the office at night shall be turned in to the Cashier on the following morning.

Disregard of the above rules constitutes a violation of the agreement with the Insurance Company that bonds our employees and any employee who does so is not only jeopardizing his position with the Company but also his ability to secure bond in the future.

(Signed) CHAS. S. RITTER,
Secy. and Treas.

Approved: V. F. DEWEY, (Signed)
Vice-Pres. and Gen. Mgr.

BULLETIN No. 262.

SUBSCRIPTIONS AND DONATIONS. January 6, 1916.

The frequency with which our employees are asked to contribute to funds raised for one purpose or another, or in behalf of some employee who is about to be married or leave our service, has been a source of hardship to those who could not afford to give, but who did not care to betray their position to others.

No employee is under any obligation to contribute to any cause that may originate in our offices nor upon the solicitation of any one, employee or otherwise, that takes place in our offices.

In order to protect employees from any embarrassment that might arise through their inability to contribute, subscription lists are tabooed, whether passed on behalf of employees, for some charity or otherwise, and those solicited are instructed to report the matter to an Officer of the Company.

(Signed) CHAS. S. RITTER,
Secy. and Treas.

Approved: V. F. DEWEY, (Signed)
Vice-Pres. and Gen. Mgr.

BULLETIN No. 263. (Revised.)

PAY FOR PROSPECTS. January 10, 1916.

This is an offer to shop men, collectors, meter readers, complaint inspector and commission salesmen who through daily contact with consumers on the outside of our office often learn about sales prospects that may be of value to the Company.

So long as it does not interfere with the work for which you are regularly employed, the Company will pay you for every prospect you turn in that is developed into a sale by the New Business Department within 30 days of the date it is received. It is not necessary for you to do any sales work, but simply fill out the regular prospect blank with the information you get and turn it in to Mr. Groff of the Appliance Department.

At the end of each month you will be paid by separate check for those prospects on which sales have been made, at the following rates:

Amberlites	$0.15
Portable Gas Lamps	.50
Gas Irons	.15
Reznor Heaters	.20
Gas Ranges	.75
Gas Range Lighters	.15
Automatic Water Heaters	1.00
Small Water Heaters	.50
Arc Lamps	.50

If the prospect you turn in is already on file, your card will be returned to you stamped "Already on file." If a sale is made within 30 days, your card will be returned stamped "Sale made." If no sale is made within 30 days, the card will be returned marked "No sale 30 days." Arc lamp prospects will be accepted only when they bring in information not already on file.

Any dispute that may arise over credit for prospects turned in shall be submitted to Mr. Fowler, Mr. Schmeltz and Mr. Kratzer who will act as committee. On their decisions, prospects will be accepted or rejected as soon as received by them.

Here is a chance for you to be of great assistance to the Company in a sales promotion way and at the same time increase your own income. Get prospect form cards No. 362 from your department head.

(Signed) Chas. S. Ritter,
Secy. and Treas.

Approved: V. F. Dewey, (Signed)
Vice-Pres. and Gen. Mgr.

The Chairman: We have some written discussion submitted on Mr. Ritter's paper, which the Secretary will read.

Mr. H. W. Hardy (Grand Rapids, Mich.): (Written discussion communicated.) Mr. Ritter's point, "Unofficial statements take an official sanction" should especially be kept in mind. Written instructions officially signed would seem to be the only way—whether the company is large or small.

Naturally it is difficult for me to look at this subject with the same viewpoint taken by Mr. Ritter, because of the great difference in the size of the Detroit office and our office in Grand Rapids. Mr. Ritter has had this problem a great many years and it has been carefully worked out and demonstrated. In Grand Rapids we are now approaching a growth which makes the Bulletin System imperative, but such need would not appear to justify the varied subjects and the detail given to each subject as it would appear has been deemed necessary in Detroit—judging from the samples of bulletins submitted, although Mr. Ritter takes pains to state that the selected bulletins are not given as models.

If I understand conditions correctly, copies of *all* bulletins issued are sent to *all* heads of departments. The educational feature and its advantage cannot be denied. It would seem, however, that bulletins sent to the heads of departments not affected, would ultimately result in making of less interest such bulletins as are strictly applicable to the department. Would it not be sufficient if copies of *all* bulletins issued were bound (loose leaf) and placed in some *central* location (possibly several binders in several locations), thereby enabling those thirsting for knowledge to get the same with a minimum effort?

Certain subjects are so general in the sample bulletins submitted that each and every department should be instructed as well as each and every employee therein—for example, No. 32, "Correct Names," No. 218, "Criticising Fellow Employees," No. 262, "Subscriptions and Donations."

On the other hand, Bulletin No. 2, "Security for Gas Bills," and No. 128, "Turning Gas Off," seem to me to be purely specific and best limited to the departments concerned.

Bulletin No. 23, "Shut Off Orders," might be even more restricted as it appears to outline a policy that would be best not to advertise any more than is necessary, especially to new employees whose discretion has not yet been proved.

In general I would suggest that while there is no doubt "The

Bulletin System as a Means of Instructing Employees" is very necessary, still there is a possible danger that it may be overdone.

MR. O. L. PALMER (Detroit, Mich.): (Written discussion communicated.) A long time ago a certain wise man, wearied by what he considered then as the sum of all things knowable, said, "Of the making of books there is no end."

Great care must be taken lest the "making of bulletins" be so considered by the very employee who ought to benefit by these direct statements of the company's policies.

Only matters of importance should be considered in bulletins.

They should be so worded that but one interpretation can be had of the meaning.

When a bulletin is issued there should be no deviation from the method of procedure laid down.

If the methods outlined become obsolete, or if a change in procedure becomes necessary, the particular bulletin applying to the case should be revised at once, and all files should be made to conform in every particular to the master file kept by the authority which issues them.

This central authority must be keenly alert to all the ins and outs of every department in order that the chain of authority binding the organization together shall have no weak spots.

Whenever a business becomes of such size that it must be conducted by departments, there immediately springs up a certain condition which follows very closely the scriptural injunction not to let the left hand know what the right hand is doing.

The very best means of keeping down this condition is the systematic issuing of bulletins which, coming from a central source, will inevitably weld and bind the whole business into one common interest for the good of the whole.

THE CHAIRMAN: There is also a written discussion by Mr. Walton Forstall.

MR. WALTON FORSTALL (Philadelphia): (Written discussion communicated.) For almost 20 years I have been very much interested in the question of affording to a large number of employees, ready access to the rules which should govern their work. The writer is quite right when he says that frequent changes are necessary to prevent them from becoming obsolete. It does not follow, however, that this is any real obstacle to furnishing printed books of instruction, and in Philadelphia we have, since 1899, governed the operations of distribution employees through two printed books, one for the street men and the other for the shop men. Changes in the rules have been cared for, whenever occasion demanded, by typewritten pasters, and at intervals of 5 or 6 years, by reprinted books. In the latest revision of the rules for our shop men, now undergoing preparation, we propose the use of loose leaves, which will enable future revisions to be made largely by the substitution of reprinted individual pages.

Having provided for the different workmen in our two instruction books, we in 1905, codified all existing regulations governing foremen and office methods of the Distribution Department. The method by which this codification is kept revised continually, and the advantages derived from it, I have described elsewhere as below.

Upon taking over the Philadelphia Gas Works from the city, the existing distribution department was found to be entirely inadequate, and it was necessary to develop an entirely new organization. In the rush of work required to retrieve the neglect of past years, there was no time to compile general rules for the conduct of the department. As one question after another arose for decision, circular letters were sent to the superintendents concerned. Occasionally the district superintendent and any of the special superintendents whose work might be affected by the subjects to be discussed, were called in conference before a decision was reached. These irregular meetings proved so helpful that it was decided to hold them fortnightly, the thought being that no time could be spared during ordinary working hours. A few meetings, however, not only showed the disadvantages of adding to the work of a busy day, but also how valuable was the benefit to be derived, entirely justifying a daytime hour, even though other work was delayed thereby. As a result, for 16 years, meetings kown as "Superintendents' Meetings" have been held every Tuesday afternoon, from 2 until 4 or 5 o'clock.

At first, only the questions actually decided upon by a meeting were covered by circular letter. Soon the thought occurred to summarize every principle subject of discussion, and this was the beginning of a regular circular letter, entitled, "Minutes of Superintendents' Meeting." Other circular letters not connected with these meetings were issued from time to time, and in several years the sum total of all the circulars became so considerable that it was not easy always to find quickly the latest ruling on any particular point. This difficulty was met by the preparation of an index comprising all the subjects covered by the distribution department, and each district superintendent was sent a set of cards containing all previous circulars, properly indexed to date. From time to time additions to this index were sent out, until it was decided to index each letter as written, and this practice, conjoined with a serial number for each letter and the numbering of each paragraph in the "Minutes of Superintendents' Meetings" absolutely identifies every entry on the index cards.

The index was a great step towards putting the responsible employees of the distribution department in possession of the rules laid down for their conduct under the many diverse conditions that constantly were arising in their contact with the public and the other departments of the company. The necessity for intimate knowledge of the rules on the part of these employees had been increased by the preparation of manuals of instruction for the guidance of the individual workman, as in a number of instances these manuals directed the workman to ask the "office," or his foreman, for guidance. The cards, however, contained many references to rules either entirely obsolete or partially changed to meet later conditions. Therefore, a codification of all existing instructions was undertaken, and this resulted in *The Digest,* containing about 300 pages of 300 words each. With its appearance, the task of the chief clerks in the district superintendents' offices became very much lightened, for the *Digest* swept away all previous circulars, and with the manuals of instruction, covered the whole field of the distribution department work.

As almost every week witnesses some slight change in practice, found wise to meet new conditions, the *Digest* is in need of continual amendment. This amendment is made half-yearly, by means of a circular letter stating what changes are to be made, giving page and line where the change is slight and enclosing a re-written page where much is altered. At the same time, another circular letter tells how the various circulars that have been issued since the last *Digest* revision, are cared for in the present revision. In this way, there is a periodical cleaning up of all temporary letters of instruction, so that at any given time, the practice of the distribution department is represented by the *Digest* as last revised and those circular letters issued since that revision.

As might be expected, this clean-out method of enabling all employees to know exactly what their duties are, has resulted in economy as well as efficiency of operation. The whole process was one of a logical evolution, and the benefits that resulted should be credited to the weekly superintendents' meeting and to the principle thus established of operation by co-operation, the managing of an organization by free consultation with those engaged in carrying out the work.

From the above experience, it would seem to us, in Philadelphia, that Mr. Ritter's ultimate goal should be the fusing of his bulletins into one comprehensive code of instructions, as only in this way can the maximum of accessibility be combined with the minimum of conciseness.

THE CHAIRMAN: Gentlemen, you have heard the reading of the paper and the written discussion upon it, and as this is a paper on a subject that interests nearly all of us, the matter is now open for discussion. I would ask the members in addressing the meeting to be kind enough to give their names for the PROCEEDINGS, in order to have a proper record.

Is there any discussion on Mr. Ritter's paper?

Mr. Paul Doty (St. Paul, Minn.): My good friend, Mr. S. J. Glass, just whispered to me that the written discussion perhaps tended to throw off the oral discussion, but this would be unfortunate if so because we all come to this meeting, and also of course to the Convention, with the idea of benefiting ourselves and ultimately benefiting our companies. I have prepared no discussion on this, but I have a few thoughts running through my mind.

Education is necessary. That seems to be self-evident, and the question is then, what is the best method of educating our employees in the line in which we wish them to work? I have tried many methods. Naturally one begins with the verbal instructions; it is the old idea of the master and apprentice; if there are but one or two apprentices, then the master can easily give the verbal instructions, and perhaps they suffice. But even to give verbal instructions means the man who gives the instructions has to be very sure of his language, as I have found in long experience that even by word of mouth they are liable to a misconstruction, and the order given verbally at one moment, after it has passed through one set of ears to another set of ears is entirely changed, and what a man may think he has said often he finds out he has not said at all. So that the first method would be the verbal instruction; that would pass away with the growth of business.

Later on there are little meetings, the employees gather, two or three or four or five, and have an exchange of ideas; this has in it the element of danger that Mr. Ritter speaks of, that some unauthorized construction may be given it.

From a meeting comes the circular letter or the Bulletin System to which Mr. Ritter refers. I have written many such bulletins, and a good deal of this language that Mr. Ritter has used in the paper that he presents seems very familiar.

Between the bulletin and the circular letter I think there is an advantage in the bulletin. It is an extremely difficult thing for any one to write a letter or write a book, but I have written books, and of instructions as well. Almost everything we do becomes obsolete in time.

All methods are good; the question is to adapt them to the circumstances as one meets them in his daily life. I would not insist upon any hard and fast rule; I would have meetings and I would have personal conversations. We have meetings in St. Paul, weekly, of the heads of departments, in the discussion of the company's business, and at times perhaps instructions are given which become embodied in the corporate history of the company, but not so much as to restrict oral discussion in the meetings. We have bulletins and they go out from the general managers' office to the heads of departments, but beside that we do have a book of instructions. I think Mr. Ritter's paper blazes the way, and points out the way, and the written discussion by Mr. Forstall—I would not say makes a good tail to the kite, because it is a very good kite itself. But the subject is important. We must know how to pass our ideas along to our employees and those who are coming after us.

MR. EWALD HAASE (Milwaukee): I notice in the specimen bulletins that they all deal with what we might call the relations of the company with the public, in the operation of the public office. If Mr. Ritter were here I should like to ask whether the Bulletin System is extended to operate in the other departments in the issuing of instructions regarding certain operations in which the office, too, might be greatly interested. In Mr. Forstall's case at Philadelphia it seems that he deals with the Distribution Department, and yet here in these specimens we see only bulletins pertaining to the operation of the office, one might say. Does any one know whether they extend that use?

THE CHAIRMAN: I rather think that the system covers many departments, but how far it extends into the various operating departments I could not say. We can only judge of that from the sample bulletins submitted with the paper.

In this connection I presume it would only be fair to submit a communication which I received from Mr. Ritter in to-day's mail, expressing his regret at his inability to be present to read his paper. He offers a few comments here and explanations which it might be well to have in the record. I will ask the Secretary to read this.

MR. J. P. CROWLEY,
Vice-President,
Accounting Section.

DEAR SIR:

It is quite doubtful whether I shall be able to attend the meeting of the American Gas Institute next week. I am very sorry, but I know you will have no difficulty in getting some one else to present my paper.

Mr. Walton Forstall was kind enough to send me a copy of his discussion on it, which I was very glad to get because it will enable me to make clear a portion that was evidently a little misleading.

In the last paragraph he states, "Mr. Ritter's ultimate goal should be the fusing of his bulletins into one comprehensive code of instructions, etc.," and in the second paragraph, "In the latest revision of the rules for our shop men, now undergoing preparation, we propose the use of loose leaves, which will enable future revisions to be made largely by the substitution of reprinted individual pages." I probably should have put more emphasis on the fact that our bulletins are kept in loose-leaf binders, arranged alphabetically according to subject and indexed numerically. Periodic revisions are thus avoided.

As for the time, place and source of initiation, I am strong on having instructions formulated at a time when the subject at hand is uppermost in our minds and that they shall be presented to the employees at that time. I am also in favor of frequent revisions, if only to simplify or clarify the language, for we know that "repetition" is next to "attention" in the laws of memorizing. Employees will not voluntarily read or memorize a rule book, but they will remember information or instructions given to them when at intense attention on a given subject. The oftener their attention is directed to the subject, the more firmly it becomes fixed in their minds.

A serious handicap of rule books is that the superintendents and foremen very frequently do not support the rules themselves, because they have had no hand in making them. If they are given a chance to initiate them or are consulted when they are written or revised, the rules have a much greater chance of being observed.

I regret very much that I will not be with you.

Cordially yours,

CHAS. S. RITTER.

MR. DOTY: In answer to Mr. Haase's question speaking from memory, I would say that the bulletins were issued by all departments and from all departments covering all classes of work, manufacturing, distribution, commercial and office, as well as the illustrative example that Mr. Ritter has put into his paper. Perhaps he is too modest to have the other bulletins here before us, but no doubt the bulletins are issued from other departments as well as the office department.

In the book of rules which we have at St. Paul, all of the departments are included as well as the office department.

MR. A. A. TREADWAY (Detroit): I think I can make that clearer by saying that all bulletins whether they appertain to matters under Mr. Ritter's direct supervision or not, are issued from his office as secretary of the company and authorized by the general manager.

THE CHAIRMAN: I think the remarks of both Mr. Doty and Mr. Treadway would cover Mr. Haase's query. I should have said in submitting this communication from Mr. Ritter that it was sent in reply to the criticisms of Mr. Forstall, upon Mr. Ritter's paper, which he very courteously and considerately sent a copy of to him, and it was to clear the matter up that he sent this letter.

H. W. PECK (Schenectady, N. Y.): I am sorry that one of the important subjects, which first came before this Section two years ago, but was transferred to the Manufacturing Section, *viz.*, "Classification of Gas Engineering," prevented my being here for the presentation of this paper and the earlier part of the discussion.

If a company is of moderate size, say between two and three hundred employees, as we have in Schenectady, I think the bulletin system is a little too cold for the greatest effectiveness. We have a general set of rules, a book, so-called, which is quite general, but specific matters are brought up, either at a general meeting of the employees or through different smaller meetings. Once a week we have a meeting of the heads of the departments and their principal assistants, one or two. There the matters are discussed; the minutes are kept, not in detail but simply conclusions reached, and they are filed. Anything of general interest, even though to one department in particular, is taken up in these department meetings, and our judgment is that we get a better understanding and more effective results from the discussion of those things than simply by the promulgation of a bulletin in cold type which may or may not be understood, and if not understood, having small chance of being questioned by any particular employee so that he will understand it.

I think the personal touch in any organization, more particularly in a smaller organization is very valuable in making effective the desires of the management.

MR. C. J. DODDS (Lawrence, Kans.): In answer to the gentleman who has just spoken I would say that I represent a small company, one of 3,500 consumers, and about ten or twelve employees. In the last year we have found the bulletin almost a necessity because certain matters that had become understood seemed to demand modification. It is our practice to keep most of our employees busy with the service gang part of the month, and as they may be needed to supplement the work of the meter setting force, or the meter reading force, to bring them in for that work; the result is that if a rule is promulgated while they are out on the service gang and then in a few days a man is brought in for other work, he does not understand the changes that may have taken place.

We have a bulletin board on which the new rules,—any changes in practice and instruction, are placed. Rule 1 is that every employee is held responsible for the knowledge on those bulletins as they are posted.

We get around the personal touch part of it through the fact that in a small organization like that, all of our men are in close touch with the management and know what is going on. If there is something they do not understand, they discuss it and we issue a supplement or written instruction, and other verbal comment on the thing as well.

Mr. F. Hellen (Rochester, N. Y.): I have had considerable experience on the question of books of rules and bulletins, and such matters. I formerly worked under a general manager when I first started out, and everything we did we tried to do with a book of rules; a book of different kind of instructions. Very fortunately after that I came under another general manager and we cut a great deal of that out, and I believe it worked better. Where I am now connected (Rochester, N. Y., since 1904), it was the policy of the general manager at that time to get up a very large volume, a book of rules. Everything was done by the same; by rules, memoranda, etc., signed by the superintendent in charge and the general manager, and the result was that if you two weeks afterwards called your employee's attention to a certain rule that was written in that book, he could not answer it. The book of rules is all right on some things, but by personal talks, such as Mr. Peck is carrying out, I believe, secured much better results.

We have discontinued this large "Volume of Instructions" that we have had, and we have very few rules at the present time.

But you take it in the shop department, the shop foreman gives his men a personal talk once a week; he goes over the different things as they come up, and he himself is kept in contact by the superintendent so that he knows what he is talking about. In that little talk to his men they are not afraid to talk, but if a man from the office of the company, or the general manager, does the talking the employees will hang back and generally will not answer his questions. I know that from my experience when I worked in the shop.

MR. DAVID A. REED (Duluth, Minn.): A great deal of complaint prevailed two or three years ago in reference to the excessive number of rules and regulations. Complaints came from our customers who said when they came to the office—I might say that this is a municipal gas plant in Duluth—that if they wanted to do something about changing their meter or their pipes, or using the gas for heating, they were referred to certain rules which barred them from doing what they desired. This resulted in a great deal of dissatisfaction among our customers. As a matter of fact, they would go over to the other utility offices where they did not seem to have as many rules, the customers could make almost any kind of a wish known—even to discounting their bills, and I understand—their wishes were acceded to simply because no rules interfered, and the result was that our "Bible," as the preceding speaker has suggested, has been retired. We have the "Bible" just the same, and the printed rules that we discuss with our employees, but we do not show them as much to the public as we did formerly, and we accomplish practically the same efficiency. We find this modification works very well.

The *Bulletin*, as we call it, is mailed each month with the monthly bills, to our customers and does not go to the employees. In that bulletin we discuss matters generally; we try to get in touch with the customers, in a friendly way, and consider matters openly and above board, even to our finances and our profits. I think it has done a great deal of good.

As to rules for our employees, the "monthly meetings" are irregular meetings, sometimes once a week. We discuss the rules so far as they apply to the conduct and work of the employees, and the employees are requested, to ask questions if they do not understand any of the rules. They take part in the discussion, and I think by that means they become more familiar with the rules and their duties than they would by simply perusing the printed rules and, as I say, both sides of the question seem to be in their proper province for the best effect.

MR. W. D. KELLEY (New York): I fail to see how a gas company of any size can get along without a book of rules for the fitting shop, and without living up to them very strictly.

We have in Manhattan a school of instruction for the fitting department. The entire course covers ten studies. As an employee is about to pass in a study, he is given a paper containing ten questions selected to show the man's knowledge of the book of rules on that subject. The employee does not know what the questions will be, but does know they will be on a certain class of work, thus, he is compelled to become familiar with the part of the book of rules relating to that particular class of work. Having passed in ten studies and having answered 100 questions, we have a very good estimate of the man's ability, as well as his knowledge of the rules of the department.

MR. CHARLES M. COHN (Baltimore, Md.): Mr. Kelley, is that school of instruction restricted to oral instruction, or to right and wrong?

MR. KELLEY: Absolutely practical illustrations. Right and wrong.

THE CHAIRMAN: We are greatly indebted to Mr. Ritter for bringing out some valuable points. The important point is the necessity for instruction of employees as Mr. Doty said, I think, using all proper means, such as meetings, the bulletin system and published rules.

Mr. Ritter's system is practically a book of rules; it is a loose-leaf book of filing and, as I take it, is revised from time to time.

There is another matter which it will be necessary for the Accounting Section to take up, and that is the appointment of a committee to select three names for submission to the General Nominating Committee as candidates for the office of Vice-President of the Section. In that connection, I will name T. V. Purcell, of Chicago, H. W. Peck, of Schenectady, and Jansen Haines, of Des Moines, as a Committee, and it is requested that the Committee make their report at to-morrow's session of the Accounting Section.

The next paper on our program is one on The Merit System, by Mr. William D. Kelley, of the Consolidated Gas Company, of New York. We are fortunate in having Mr. Kelley with us to read his paper.

MR. W. D. KELLEY: I will not read the entire paper, Mr. Chairman, but rather the introduction which is taken verbatim from the paper. It will explain perhaps why the merit system works well with us while it might not work so well with others.

MERIT SYSTEM FOR THE EMPLOYEES OF THE FITTING DEPARTMENT OF THE CONSOLIDATED GAS COMPANY OF NEW YORK AND AFFILIATED COMPANIES IN THE BOROUGHS OF MANHATTAN AND THE BRONX.

Before proceeding to outline the operation and result of the Merit System it may be interesting to bestow a passing glance at some of the principal causes that led to its adoption.

The employees of the fitting department do all the company's work on the consumer's premises from the head of the service to the point where the gas is consumed. This includes setting and exchanging meters, leaks, stoppages of all kinds, indexing, high bill complaints, and all other miscellaneous work necessary to the successful and satisfactory distribution of gas.

In addition to this there is the installation, exchanging, and maintenance in repair and adjustment of all appliances from the small domestic to gas-fired steam boilers, and when it is remembered that the appliance rental system obtains in all companies in the twin boroughs, the preponderance of labor contributed to the fitting department from this source is obvious.

In performing this work it is quite apparent how impossible it is to have the fitters and their helpers under the supervision of a foreman or superintendent at all times, or even for a very small percentage of the working day, scattered as they are over the entire city, except at a cost out of ratio to the result obtained. There is therefore, no alternative but to leave them largely to their own resources and the amount of work done or "Tickets Executed" depends solely on the individual's fitness, honesty, industry and his sense of fairness to the company. In a body of 1,200 men (there are about that number employed) there are the good, the bad, and the indifferent, but the superintendents of the different shops know them all individually and have in their minds a fair estimate of each man's ability and value. This opinion is formed by watching the number of completed tickets turned in by the different men, from the foremen's report, from occasionally inspecting the man's work on the district, and from his school record.

The above method is intangible and unsatisfactory. The superintendent's judgment may not at all times be right, for no man is infallible and although he is in close contact with his men, an unconscious mental prejudice might unfairly operate against an employee's just advancement, as all recommendations for wage adjustments are made by the superintendent. This is a serious responsibility to place on one man's shoulders without some accurate standard helpful in appraising a man's worth.

It was with the two-fold purpose of creating this standard in shop operation and with the thought of encouraging the men in the faithful and intelligent performance of their duties and benefiting them according to their deserts, that the Merit System was inaugurated.

The number of trivial irregularities, or offences to which employees are liable, which while of little account singly, when considered collectively are an impairment to efficiency, as well as a stumbling block to the proper maintenance of shop discipline. The introduction of the Merit System has in a large measure removed this trouble.

The principal elements of this system are:

1. A specific number of demerits are imposed for various infractions of the rules and for improper or unsatisfactory work, also for incomplete or incorrect reports.

2. Against these demerits four credits are given for a month's perfect work, that is, a month without demerits.

3. The credits balance or cancel a like number of demerits, which allows a man to improve his standing by good work. This is a very important feature of the system as it encourages a man to strive for a perfect month in order to better a previous month's standing, and prevents the employee from becoming disheartened due to a poor start.

4. The standing of the men is posted in the different shops at the end of each month.

5. Cash prizes are awarded semi-annually to those men with the best records, and also any increases in pay depend in a measure on their standing in the Merit System.

6. The system considers only the quality of the work done, and in no way the quantity. The superintendent is responsible for the execution of the work and from his reports can usually ascertain whether or not a man is "soldiering."

The number of demerits to be imposed was established by a committee of the shop superintendents who made a complete list of all the errors and omissions the men were liable to make in the prosecution of their work. Their report contained some 563 items which were reconsidered and reduced to 340 in number. These 340 errors or infraction of rules were then reviewed with great care and the number of demerits each was to carry was established, by considering comparatively their degree of seriousness in regard to the company's relation to consumer and the safety of the public and employee. The number of demerits imposed ranged from 1, for a slight clerical error to 15 for the more serious offences, these being those omissions of duty which would entail loss to the company and cause annoyance or inconvenience to the consumer.

Serious offences which warrant discharge are not considered in this system. For less serious infractions of rules an employee may be laid off for a time. He then ceases to participate in the semi-annual competition, but is eligible for the next period.

The alloting of demerits was a difficult task as each offence had to be carefully weighed with every other because "fairness to the men" was the principal around which this system was developed and consequently the penalties had to be relatively fair. A tribute to the success of the efforts in this regard lies in the fact that there has never been a complaint that the system was in any way unfair and the number of demerits has not been changed since it was inaugurated, although criticisms are always welcomed from the men and their foremen, and the system is always under the close scrutiny of the general office.

After the number of demerits for the various offences had been established it was difficult to adjust the system to harmonize with the School of Instruction which is the training ground of the companies fitters who are naturally in preparatory and progressive stages of advancement.

In this connection a short digression may be pardonable in order to outline the inauguration and functions of the School of Instruction which in the course of this paper is occasionally referred to. Scarcity in the labor market, of skilled help suitable for gas company work and the rapid development and improvement in gas appliances were the principal causes for establishing the school. The latter condition practically eliminated the ordinary, or old time gas fitter as a producer in the fitting department.

The function of the school is to have thoroughness and uniformity in technical training, method, and policy, common to all shops and that the educational development of the mechanical force may keep pace with the continuous development in domestic, industrial, and commercial appliances.

It was decided that it would be unjust to demerit the new man until he had opportunity to attend the school and learn our practice, except for such offences as tardiness, untidiness, incivility, etc. These men are therefore immediately sent to school in working hours, and receive full pay while there. Their course is graduated in the various phases of gas company work, from indexing or the elementary work to the more complicated mechanical work such as, repairs and adjustments of appliances, meter work, complaints, leaks, appliance installations, etc.

After the new employee has successfully passed in the school upon a certain line of work he is sent out on the district on the same work with a district instructor. When sufficient time has been spent on the district with the instructor and the new fitter is pronounced fully qualified he is then liable to be demerited for deficiency in that particular class of work. This process is repeated with each subject until the student attains the rank "all around fitter," that is qualified to do all classes of fitting department work.

To be positive these men are qualified, the rules require that they spend from one to two months on the district after passing in school and in that time not less than one or two weeks with a qualified instructor, depending upon the kind of work. They are then examined and if qualified, "passed" by a district foreman. After such a thorough and extensive drilling and training there can be no question as to the justice of imposing demerits.

The preparation required on each class of work before demerits are imposed is as follows:

Indexing.—A man must index 18 books (approximately 300 indexes per book) within two months after passing this subject in the school.

Appliance Repairs and Maintenance.—An employee must have two months experience on the district after passing in the school and in that time the employee must spend one week with a district instructor, and then be passed by a district foreman. He must also within this time have had 30 full days alone on repairs.

Meter-Locks and Unlocks.—An employee must have 30 days on this class of work within two months after passing in the school and during this time one week with district instructor. He is then passed by a district foreman.

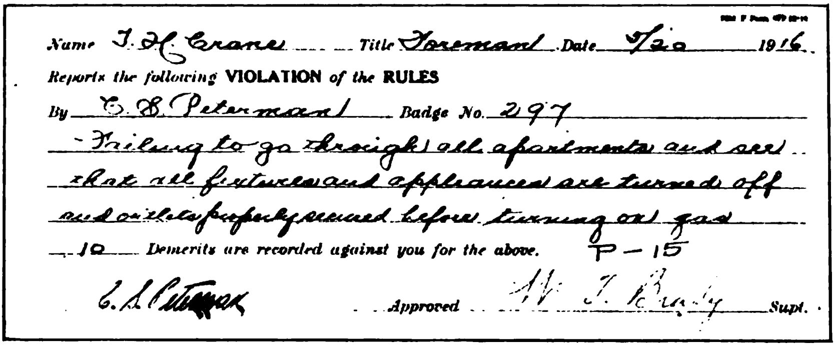
Complaints and Leaks.—An employee must have two months district experience after passing in the school and in that time two weeks with a competent instructor. He must then be passed as qualified by a district foreman.

Appliance and Meter Installations.—An employee must have two months district experience after passing in the school and in that time two weeks with a competent instructor. He must then be passed as qualified by a district foreman.

Each shop is divided into 10 sections under this system irrespective of the number of men in the shop. One shop may have 10 men to a section and another 8, but by this means a comparison of the efficiency of any two men in different shops is readily made. Also in speaking of a man in a certain section it immediately conveys an idea of that man's proficiency, whereas without any sections a man being No. 54, would mean little without knowing the number of men employed in the particular shop.

Demerits are imposed by the assistant superintendent or the clerks in the shop office who read the completed tickets to see if the work is properly reported and that the commercial department has all the information required. The district foremen who inspect the fitter's work on the district to see that it is properly executed also impose demerits.

Each time a man receives a demerit he is required to sign a demerit slip (Plate 1, 1a, 1b, 1c) which states the number of demerits incurred, the cause and by whom reported. This gives the employee an opportunity to explain his error, or claim exemption and when signed by him any future controversy as to the number of demerits received is avoided. If the employee is not satisfied that he had made an error for which he should receive demerits, he is shown his mistake in the shop if a clerical omission, or if the work in question is on the district he meets his district foreman there who shows him wherein he was wrong. If any doubt remains, the superintendent may go in person and decide, always giving the benefit of any doubt to the man. This trouble and expense is justified because the men must realize that the system is absolutely fair and that it is impossible for them to receive demerits they do not deserve. Likewise at the end of the month if a man has a per-



Name J. H. Crane Title Foreman Date 5/20 1916

Reports the following **VIOLATION** of the **RULES**

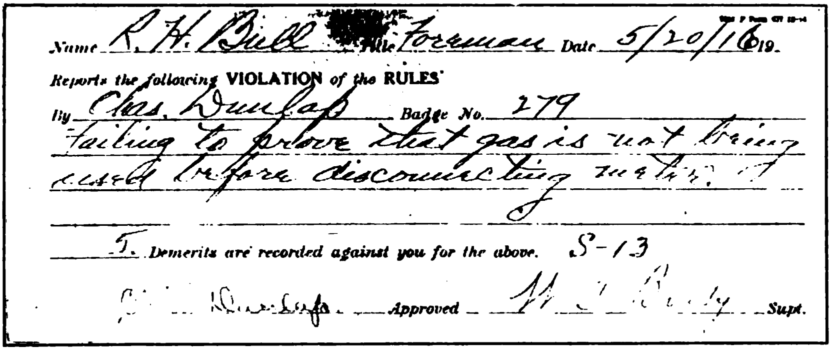
By C. S. Peterman Badge No. 297

Failing to go through all apartments and see that all fixtures and appliances are turned off and outlets properly secured before turning on gas

10 Demerits are recorded against you for the above. P – 15

C. S. Peterman Approved W. J. Brady Supt.

PLATE 1.



Name R. H. Bull [illegible]le Foreman Date 5/20/16 19

Reports the following **VIOLATION** of the **RULES**

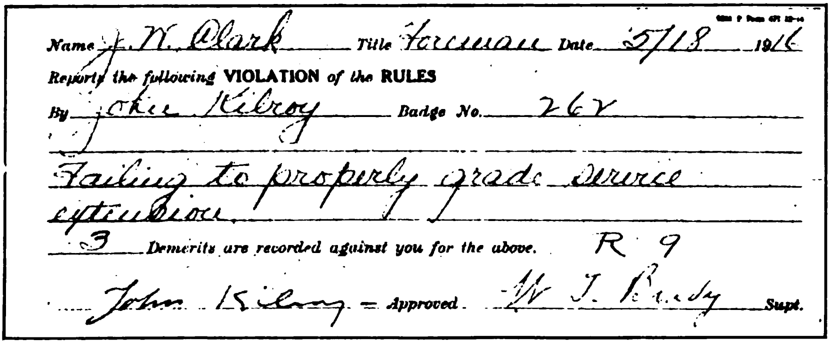
By Chas. Dunlap Badge No. 279

Failing to prove that gas is not being used before disconnecting meter.

5 Demerits are recorded against you for the above. S-13

Chas. Dunlap Approved W. J. Brady Supt.

PLATE 1a.



Name J. N. Clark Title Foreman Date 5/18 1916

Reports the following **VIOLATION** of the **RULES**

By John Kilroy Badge No. 268

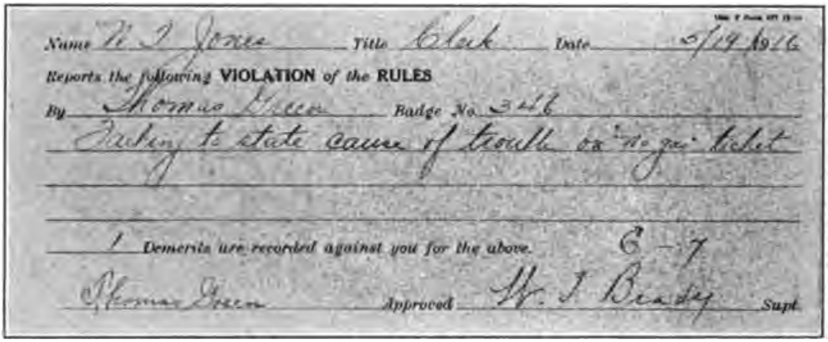
Failing to properly grade service extension.

3 Demerits are recorded against you for the above. R 9

John Kilroy Approved W. J. Brady Supt.

PLATE 1b.

fect record he signs a credit slip (Plate 2) for 4 credits, with a word of commendation from the superintendent. Credit slips are always signed without argument. These slips are also approved and signed by the superintendent and then filed in the employee's record envelope (Plate 3 about ⅛ size).



Name W. T. Jones Title Clerk Date 5/19 1916

Reports the following **VIOLATION** of the **RULES**

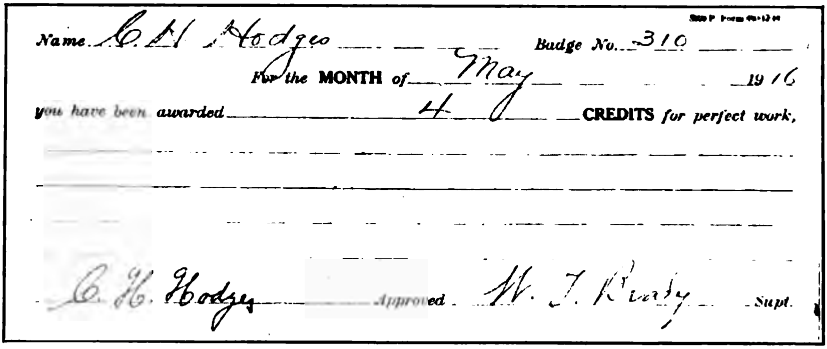
By Thomas Green Badge No. 346

Failing to state cause of trouble on "No go" ticket

1 Demerits are recorded against you for the above. E-7

Thomas Green Approved W. T. Brady Supt.

PLATE 1c.



Name C. H. Hodges Badge No. 310

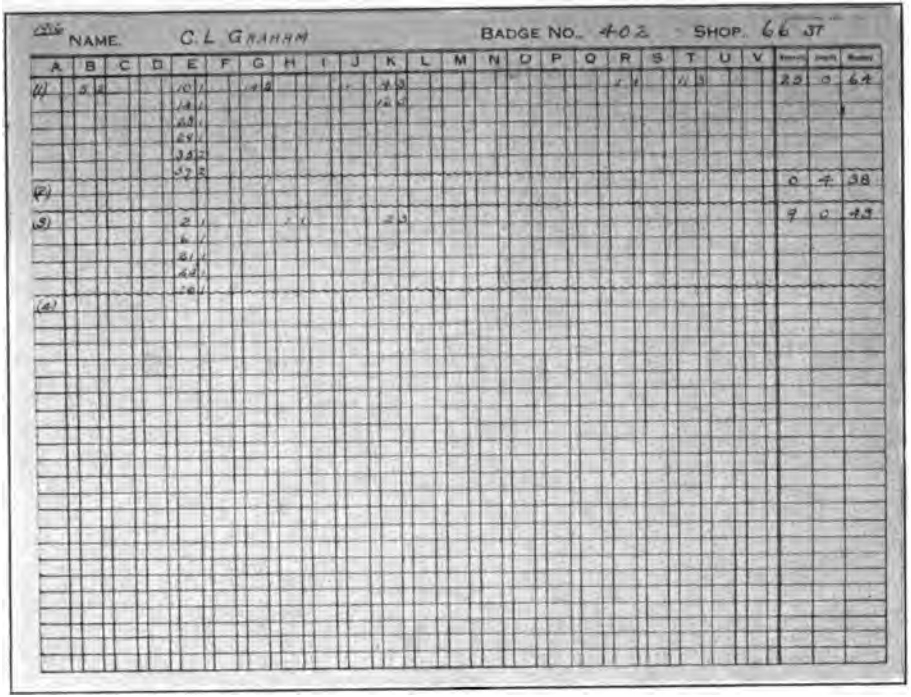
For the **MONTH** of May 1916

you have been awarded 4 **CREDITS** for perfect work,

C. H. Hodges Approved W. T. Brady Supt.

PLATE 2.

All the offences and the penalty or number of demerits each carries are printed in book form, properly indexed and are posted in all the shops for ready reference by the men so that they can check the number of demerits received for each offence.



NAME. C.L GRAHAM BADGE NO. 402 SHOP. 66 ST

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(4)																								

PLATE 3.

EXHIBIT "A."

CONSOLIDATED GAS COMPANY OF NEW YORK

AND AFFILIATED GAS COMPANIES IN THE BOROUGHS OF MANHATTAN AND THE BRONX.

MERIT SYSTEM.

FITTING DEPARTMENT.

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ACCIDENTS.

(A)

Failing to:	Demerits
1. Report an accident, its cause and all particulars promptly	5

APPLIANCE DELIVERY, INSTALLATION AND REMOVAL.

(B)

Failing to:	Demerits
1. State whether for Company's or Consumer's benefit when ordering location of appliance changed and that permission is granted	1
2. Attach tag to meters or appliances when bringing in.......	1

APPLIANCE DELIVERY, INSTALLATION AND REMOVAL.—(*Continued*)

Failing to:	Demerits
3. Use proper pipe fastenings	2
4. Guard against using too many fittings	2
5. Report that appliance obstructs use of fire exit when measuring or setting	2
6. Instruct the Consumer how to use the appliance	2
7. State only approximate time to heat contents of boiler	2
8. Report missing parts on "Bring In" orders	2
9. Verify style and rental number of appliance before exchanging	2
10. Set appliances level	2
11. Prove on rental or installment order that your company supplies	3
12. Properly secure all parts when removing an appliance	3
13. See that pilots operate properly	3
14. Leave an appliance in proper condition or report if unable to do so	3
15. See that no parts are missing or broken	3
16. Properly grade cellar lines	3
17. Set appliance in a safe place	3
18. Return old material and have it properly checked	3
19. Provide proper wall protection	3
20. Have cock control the supply before using Right and Left fittings	3
21. Place a hose cock a safe distance from a burner cock	3
22. Observe rule not to connect rental or installment appliance with tubing	3
23. Report that premises are not in proper condition to deliver or connect appliances	3
24. Instruct Consumer that range and water heater cannot be used at the same time to advantage on small piping	3
25. Observe that all parts are fitted properly	3
26. Avoid straining cock on manifolds	3
27. Prove that work is O. K. when so reporting	3
28. Take proper measurements or to remeasure	3
29. Properly secure piping and all outlets when removing appliances	5
30. Prove that appliance is connected to proper meter	5
31. Use Right and Left fittings properly	5
32. Observe rule not to set appliances under meter	5
33. Leave old range in a safe and proper place	5
34. Complete an exchange when possible on first call	5

APPLIANCE DELIVERY, INSTALLATION AND REMOVAL.—(*Continued*)

	Failing to:	Demerits
35.	Put up connection and lock controlling cock if appliance is incomplete	5
36.	Safeguard against fire when setting appliances	5
37.	Measure on delivery when possible	5
38.	Use back draught tee on flue connections	5
39.	Guard against breakage on installation	5
40.	Test tubing for leaks	5
41.	Remedy or report defective conditions	5

BURNERS.

(C)

	Failing to:	Demerits
1.	Use burners as stated in report	1
2.	Notify Consumer that Governor Company will attend to complaint when such a device is in service, and so report	1
3.	Use water gauge and pocket meter	3
4.	Properly remedy all burner complaints when possible	3
5.	Prove that work is O. K. when so reporting	3
6.	Guard against leaving leaks when putting on burners	10

CARTAGE.

(D)

	Failing to:	Demerits
1.	Make special deliveries when tickets call for same	2
2.	Carry meters in an upright position, properly bagged and corked	2
3.	Guard against breakage	3

CLERICAL AND REPORTS.

(E)

	Failing to:	Demerits
1.	Leave call cards or any other forms in use	1
2.	Notify office of wrong name or address	1
3.	Write up tickets properly	1
4.	Check mark thus (√) the items on reverse side of complaint tickets in frost periods	1
5.	Report cleared with or without pump and what removed	1
6.	State on ticket the name of Governor Company if the device is out of order	1
7.	State cause of trouble on "No Gas" ticket	1

CLERICAL AND REPORTS.—(*Continued*)

Failing to:	Demerits
8. Report unconsumed gas due Consumer when exchanging Prepayment Meter and also report unconsumed allowed on new one	1
9. Report according to rule, "I locked," "I found meter locked"	1
10. Report according to rule, "I unlocked and tested," "I found unlocked", etc.	1
11. Give number, size of meter and location of leak on other Company's meter	1
12. Report cause of complaint if other than stated on ticket	1
13. State name of person to whom notice has been given to have leak repaired if not Company's work	1
14. Report part of meter that leaks	1
15. State name of party seen and whether they are satisfied	1
16. Report on ticket why successor will not surrender stove on removal order	1
17. State why appliance is disconnected, and if temporary or permanent	1
18. Report names and addresses of those not familiar with use of appliances so that demonstrator may be sent	1
19. Write up paster on meter	1
20. Report style number and location of appliance on appliance order	1
21. Report meter number if upstairs meter	1
22. Stamp time sheet on leaving and state address of last job when not returning to shop	1
23. Report who seen, what time, part supplied, size and number of meter	1
24. Keep office tickets clean and do not scribble sketches on them	1
25. Use continued report slip when necessary	1
26. Report D. N. R. on tickets not reached	1
27. Write on set tickets, "Set and tested O. K."	1
28. Report condition of burners	1
29. Report "Consumer lighted range properly in my presence"	1
30. Put helper's name on location slips	1
31. State reason for measuring to reset	1
32. Write reports on tickets at time work is finished	2
33. Correct wrong address on orders	2
34. Report reason for exchanging meters or appliances	2
35. Report size, number, and whether ordinary or prepayment meters	2

CLERICAL AND REPORTS.—(*Continued*)

Failing to:	Demerits
36. Obtain proper information on all applications	2
37. Supply all mechanical information on sketch tickets	3
38. See that leak tickets are time stamped before leaving shop	3
39. Measure for or report no meter set when measuring for appliance	3
40. Report broken castings that will cause damage	3
41. Report new piping	3
42. Report water heaters not operating satisfactorily	3
43. Report immediately stove explosion to man in charge of shop	5
44. Advise shop of necessity to exchange meter	5

Same clerical error on a number of tickets same day 1 demerit; not one demerit for each ticket.

COMPANY'S PROPERTY.

(F)

Failing to:	Demerits
1. Have old material checked when brought in	2
2. Observe and report meters with dial glasses broken	2
3. Leave old or unused material in a safe place for vehicle to bring in	3
4. Return locks to shop	3

COMPLAINTS.

(G)

Failing to:	Demerits
1. Notify consumer that complaint has been attended to	1
2. Carry a few burners	2
3. Prove that meter registers on small light, after removing condensation	2
4. Obtain and report that permission is granted to apply pump to house pipes	2
5. Prove that drips are clear after pumping	2
6. Leave printed notice why gas cannot be turned on	2
7. Report cause of chronic complaints and how to remedy	3
8. Guard against meter acting as a drip	3
9. Measure fot or report larger drip necessary	3
10. Prove that trouble is in governor before so reporting	3
11. Report inadequate branch service conditions	3
12. Attend to complaint if governor is out of action	3
13. Clear meter	3
14. Prove that burners ordered are necessary	3

COMPLAINTS.—(*Continued*)

	Failing to:	Demerits
15.	Prove that work is O. K. when so reporting	3
16.	Prevent back pressure from pump getting into meter	5
17.	Prove pump needed	5
18.	Remedy on first call when possible	5
19.	Prove that service could not be cleared before so reporting	5
20.	Clear street service when meter cocks are accessible, or where there is a controlling cock	5
21.	Phone to shop for instructions when finding meter locked on "No Gas" complaint	5
22.	Deodorize with "Germo" or other approved disinfectant	5
23.	Report that a good service is available if one in use cannot be cleared	5
24.	Notify consumers and janitor that gas is being turned on or off of the building	10
25.	Prove that supply is O. K. throughout when so reporting	10

EQUIPMENT.

(H)

	Failing to:	Demerits
1.	Keep lockers and tool bags free from an excess quantity of nipples, fittings or other material	1
2.	Withdraw tool tickets and return large tools promptly	2
3.	Carry extra nipples and fittings to complete job on first call	3
4.	Go out properly equipped at all times	5

HABITS AND CONDUCT.

(I)

	Failing to:	Demerits
1.	Observe rule that employees must not enter into argument with Consumers, but report facts to their superior	3
2.	Maintain a tidy appearance	3
3.	Refrain from smoking or drinking on Consumer's premises	5
4.	Be respectful and courteous to Consumers	5
5.	Observe the rule that employees must not assign their wages	10

INDEXING.

(J)

	Failing to:	Demerits
1.	Report alteration or B. C. D.	1
2.	Report why access cannot be gained	1
3.	Report meters located in dangerous or inaccessible places	1

INDEXING.—(*Continued*)

Failing to:	Demerits
4. Note in index book changes in apartments or house numbers	1
5. Compare the entire meter number	1
6. Read index correctly	1
7. Take proper index	1
8. Make return call on meters you were unable to index	1
9. Report meters not listed giving address, location, number and when installed	1
10. Note meters exchanged and to take new meter number and index	1
11. Report meters not properly supported by shelf	1
12. Obey the rule not to make memorandums on cover of index book	1
13. Make out shop index slip immediately upon your return	1
14. Give complete information on skip tickets	1
15. Use prescribed abbreviations	1
16. Make proper effort to get an index	3
17. Use an electric torch while indexing meters	5
18. Obey the rule not to state amount of Consumer's bill	5
19. Report a leak	5

LEAKS.

(K)

Failing to:	Demerits
1. Make proper effort to see an adult when answering a leak complaint	3
2. Examine the repaired leaks when verifying	3
3. Prove that a strain causes the leak, and report what is necessary to remedy	3
4. Determine and report extent of leak if at outlet of meter, outlet connection or house pipes	3
5. Prove that work is O. K. when so reporting	3
6. Make proper temporary repairs	5
7. Repair leak that is Company's work	5
8. Get instructions from shop, if locking meter is objected to	5
9. Notify Consumers why gas is shut off	5
10. Properly report leak complaint, known to be chronic	5
11. Repair any leak permanently when possible on first call	5
12. Prove that leak was as reported and that there are no other leaks	5
13. Await arrival of Street Department and report name and time of man relieving	5

LEAKS.—(*Continued*)

	Failing to:	Demerits
14.	Report and repair temporarily leaking dial glasses	5
15.	Order meter exchanged at once if necessary	10
16.	Guard against leaving leak in doing any kind of work	10
17.	Guard against careless use of flame	10
18.	Lock a controlling cock if leak is serious enough	10
19.	Notify shop at once after locking a service cock	10
20.	Test all piping after repairs are made, before leaving gas on	10
21.	Notify shop at once, if strong odor of gas cannot be located, and await assistance	10
22.	Notify shop at once, of a leak requiring immediate attention of Street Department	10
23.	Ventilate and use other proper precautions	10

LOCKS AND UNLOCKS.
(L)

	Failing to:	Demerits
1.	Answer all questions printed on reverse side of order	1
2.	Get application signed when possible	1
3.	Get application signed, take index and deposit receipt number when finding successor using gas on an order to lock	1
4.	Unlock all meters necessary to supply and so report	3
5.	Note and report defective meter conditions	3
6.	Take measurements where there is no meter	3
7.	Telephone to other Company when their meter supplies	3
8.	Prove that work is O. K. when so reporting	3
9.	Have Consumer sign reverse side of lock order when meter is not to be locked	3
10.	Report meter number and index or that meter is inaccessible on a call	3
11.	Report new piping or alteration	5
12.	Prove that meter supplies part and party called for on order	5
13.	Enter apartment before proceeding with execution of order	5
14.	Observe rule that meters must not be unlocked unless test can be obtained through fixtures or appliances	5
15.	Prove that meter should be locked	5
16.	Give gas when possible and proper to do so	5
17.	See that all outlets are properly secured	10
18.	Prove that house pipes are tight before leaving gas turned on	10

METER WORK.
(M)

Failing to:		Demerits
1.	Mark part supplied on shelf and paster	1
2.	Set meters level	2
3.	Report damaged meters	2
4.	Take proper measurements, or remeasure	3
5.	Put on service controlling cock	3
6.	Order shelf, and put it up properly	3
7.	Gas out properly	3
8.	Provide proper swings	3
9.	Use ells instead of tees in apartment sets	3
10.	Use tees on bottom of riser in cellar sets	3
11.	Discover and report defective meter cock (passing gas when shut off)	3
12.	Install by-pass on 100 lt. meters and larger for fuel	3
13.	Set meter in proper location and height	3
14.	Remedy or report poor supply	3
15.	Prove that work is O. K. when so reporting	3
16.	Prove that your company controls rising service	5
17.	Place cock in an accessible position	5
18.	Set all meters needed	5
19.	Provide necessary drips	5
20.	Set proper size meter for adequate supply	5
21.	Observe and report new piping or alterations	5
22.	Lock cock, plug or cap service and house pipes when removing meter	5
23.	Prove gas in service when measuring	5
24.	Discover back pressure of gas or air	5
25.	Prove that meter is not being used before disconnecting	5
26.	Avoid strains	5
27.	Prove that meter supplies party and premises called for on order	5
28.	Prove that meter registers on test dial, with a small light	5
29.	Lock meter cock when putting up connections only	5
30.	Lock or disconnect if leak is in house pipes	10
31.	Have rising service tested with water gauge, before turning on gas	15

MISCELLANEOUS.
(N)

Failing to:		Demerits
1.	Order burners exchanged when necessary	1
2.	Report apartment vacant and meter not locked	1

MISCELLANEOUS.—(*Continued*)

	Failing to:	Demerits
3.	Report meter will not be used	1
4.	Have Consumer sign high bill order if satisfied	1
5.	Prove whether the governor is in action or not	3
6.	Prove that no other party is using gas from meter	3

PREPAYMENT WORK.

(O)

	Failing to:	Demerits
1.	Detect over-delivery	3
2.	Prove that meter delivers the proper amount and registers on test hand on main dial	3
3.	Make collection when repairing meter	3
4.	Guard against ordering meter exchanged unnecessarily	3
5.	Note collections from Prepayment meters by placing printed form in cash box	3
6.	Allow unconsumed when proper to do so	3
7.	Instruct Consumers how to operate Prepayment meter	5
8.	Turn in cash collection	5

PROTECTION OF CONSUMERS AND COMPANY.

(P)

	Failing to:	Demerits
1.	Leave meter cock adjusted as found	2
2.	Notify shop of bad service or meter conditions	2
3.	Lock meter if fixtures or appliances are not connected	3
4.	Leave old meter in safe place when not returning to shop	3
5.	Guard against damaging Consumer's property	3
6.	Prove that work is O. K. when so reporting	3
7.	Report to man in charge any sickness or accident employee may learn of resulting from gas	5
8.	Use proper precautions as to ventilation and light when working in dark places	5
9.	Install drip in a safe place	5
10.	Prove not Company's work before ordering owner to repair	5
11.	Report damage to Consumer's property	5
12.	Return meters dropped or otherwise damaged	5
13.	Notify proper persons when gas is turned off or on	10
14.	Give gas where the Company is involved through meter being locked in error, or service cock and street valve shut off	10

PROTECTION OF CONSUMERS AND COMPANY.—(*Continued*)

	Failing to:	Demerits
15.	Go through all apartments and see that all fixtures and appliances are turned off and outlets properly secured before turning on gas	10
16.	Shut off main stop cock or plug service before working on live gas	10
17.	Light all pilots when turning on gas	10
18.	Shut off meter cock for safety	10

ROUTINE.

(Q)

	Failing to:	Demerits
1.	Report change of home address	1
2.	Carry Book of Instructions when on duty	1
3.	Observe rule that wording on face of tickets must not be changed	1
4.	Charge time properly and legibly	1
5.	Turn in location sheets	1
6.	See that location sheet is signed and time stamped before leaving shop	1
7.	Notify shop of intended absence before 8 A. M.	2
8.	Report punctually for work, without proper excuse	2
9.	Notify shop of change of route	2
10.	Try pump before leaving shop	2
11.	Have test hand moving upward when testing	2
12.	Notify Consumer why order cannot be executed	2
13.	Route work properly on location sheet	2
14.	Use plyers instead of wrench on 3 and 5 ft. meter couplings	3
15.	Have a General Office order before doing any kind of appliance or fitting work in a public building	3
16.	Turn in tickets immediately upon return to shop	3
17.	Return time cards at proper time	3
18.	Report at school on time	3
19.	Use white lead or other approved jointing compound carefully	3
20.	Use "Gredag" on leaky fixture keys, appliance and meter cocks	3
21.	Prove that work is O. K. when so reporting	3
22.	Report immediately the loss of badge or keys	3
23.	Return keys when borrowed	3
24.	See District Foreman when ticket is so marked	3
25.	Failing to have tools checked and inspected when so ordered	3

ROUTINE.—(*Continued*)

	Failing to:	Demerits
26.	Send tickets to shop promptly when absent	5
27.	Reach job at time appointed	5
28.	Remedy existing conditions temporarily and take a measurement to repair permanently	5
29.	Report and have missing tools replaced at once	5
30.	Turn in coupon with cash	5
31.	Obey orders	10

SERVICE INSTALLATION AND JOBBING.

(R)

	Failing to:	Demerits
1.	State whether for Company's or Consumer's benefit when ordering location of meter changed, and that you have permission to do so	1
2.	Notify proper person to have repairs made if not Company's work	1
3.	Report bad conditions of street services	2
4.	Use special plugs according to instructions	2
5.	Order alteration to piping when necessary	2
6.	Prove that exchange of meter was necessary	3
7.	Use old material when suitable	3
8.	Remedy or report trapped conditions	3
9.	Properly grade extension of service or house pipes	3
10.	Obtain proper authorization before removing governor	3
11.	Provide blow-out on head of service	3
12.	Prove that work is O. K. when so reporting	3
13.	Provide necessary drips	5
14.	Extend service proper size	5
15.	Report or replace defective lead connections with iron	5
16.	Order or install proper size pipe	5
17.	Obtain permission before changing location of meter	5
18.	Prove pipe gas tight after pumping	10

SERVICE TO CONSUMER.

(S)

	Failing to:	Demerits
1.	Allow sufficient time to do work when making an appointment	1
2.	Refer Consumers and the public to office for information	1
3.	Leave work in a tidy condition by removing superfluous lead, etc.	2
4.	Report on call how, and at what time order can be executed	2
5.	Notify Consumer why job could not be completed	2

SERVICE TO CONSUMER.—(*Continued*)

	Failing to:	Demerits
6.	Report complaints of neglect made by Consumers	3
7.	Make every effort to satisfy Consumer	3
8.	Prove that work is O. K. when so reporting	3
9.	Refrain from boring through or damaging mantles, chair rails, or wood trim of any kind unless by special order	5
10.	Prove by going to apartment that there is no one home and do not take the janitor's word for it	5
11.	Reach tickets when D. N. R. already appears on same	5
12.	Telephone to shop when a special order cannot be executed	5
13.	Prove that gas is not being used before disconnecting	5
14.	Notify shop where meters have been left shut off after clearing service	5
15.	Reach a "special" or "to-day" ticket	5

STOVE REPAIRS.
(T)

	Failing to:	Demerits
1.	Remove old stove repair material from Consumer's premises	1
2.	Get release signed before installing flue connection	2
3.	Inform operator that both burners cannot be used at one time in a single oven stove	3
4.	Observe that a stove is in good working order in every detail when reporting that all is O. K.	3
5.	See that oven is properly ventilated	3
6.	Observe that all burners are properly adjusted	3
7.	Observe that all parts are fitted properly	3
8.	Regulate when material is to follow	3
9.	Report style and number of appliance and order proper material	3
10.	Detect and report, or remedy cause of poor supply	3
11.	Remove stoppage in orifice tube, port holes or any part of a manifold or burner	3
12.	Detect badly warped baffle plates and burners	3
13.	Detect and remedy any defect in burner cocks	3
14.	Detect that body of appliance is rusted through	3
15.	Use all means to repair appliances before ordering exchanged	3
16.	Prove that work is O. K. when so reporting	3
17.	Remove flue connection or so report where there is a back draught	5
18.	Prove there is no back draught before ordering or connecting flue	5

TRANSPORTATION.

(U)

Failing to:	Demerits
1. Use carfare as such	10

These credit and demerit slips are placed in the employee's record envelope which are filed alphabetically. At the end of each month the number of credits and demerits is balanced and the employee's relative standing for the month is noted on the envelope in the column under the heading "Standing." At the ending of the second month the two months are combined and so on until the six months period is complete. It will be noticed that across the top of the envelope are letters from "A" to "V" inclusive. These letters correspond to the index letters in the "Demerit Book," and represent the different classifications of work, such as, "G"-Complaints, "I"-Habits and Conduct, "M"-Meter Work, etc.

After a fitter's record is balanced at the end of each month the number of demerits incurred in each class of work is entered on the face of the envelope under the proper letter. By listing the demerits in this manner a glance at the record envelope shows the superintendent in what kind of work the employee is deficient, and he can then intelligently help the employee to overcome and correct his faults. The credit and demerit slips and the record envelope are all the forms necessary for the efficient running of the system and the clerical help necessary to keep the records is practically "nil."

At the end of every month the standing of the men is posted in each shop on the bulletin. (Plate 4 about ⅛ size). The ten men (if the shop employs 100 men) with the highest standing compose the first or honor section, the man with the most perfect record being first on the list, next best number two, and so on to the last man in the last section.

At the end of each six months, November 30th, and May 30th, cash prizes are awarded to the five men in each of the

PLATE 4.

ten shops who have the best records for the period, distributed as follows:

1st Prize	$25.00
2nd Prize	17.50
3rd Prize	12.50
4th Prize	10.00
5th Prize	7.50

and also cash consolation prizes to the next five men.

As increases in pay are also largely based on a man's standing in the Merit System, this is an additional inducement for a man to keep a good average record by close attention to duty. In considering a man's record in the Merit System for wage adjustment due allowance is made for the new man at a low rate, as it is not expected that his record will be as perfect as the experienced fitter.

Wage increases are largely based upon which section a man is in, and his present wage. For instance a fitter earning $3.00 a day must usually be in the first or second section to receive an increase, while a helper getting $2.00 a day may be in the sixth section or better and be eligible. The time that has elapsed since the last wage increase is always taken into consideration.

It is the policy of the department to keep the entire force steadily employed during the full year if it is possible. However, at times, due to the fluctuations in the volume of work or orders received at different seasons of the year, this is impossible, as in the spring and fall the work is very heavy, and then usually dull periods are encountered, during the summer, and at times in the winter months. During these dull periods it is necessary to decrease the force. This is done by laying off some of the men in the lower sections and rotating this among the men to make the individual burden as light as possible. It is only fair when this condition arises that the men with the better records are kept at work, and those who have a low standing be laid off, this forming another incentive for the men to maintain a good record in the system.

The Merit System has now been in operation about two years. Since its adoption the quality of the work has improved and the cost decreased. This is due largely to the fact, that it is seldom necessary to go back to pick up any odd ends, or to obtain any information required on the tickets. Also less trouble is caused the consumer as fewer calls are made.

The men like the system and take great pride in their standing and are at all times working to improve their rating.

The Merit System has been the means of obtaining whole hearted co-operation from the men in satisfying and rendering good service to the consumers, and it is believed that the companies have been benefited by its adoption.

THE CHAIRMAN: We have one written discussion on Mr. Kelley's paper. It is brief and I think it would be well to have the Secretary read it.

MR. B. F. PELTON (St. Paul, Minn.): (Written discussion communicated.) Mr. Kelley's paper requires study to get at the real benefits of the system described. He has been very modest in his statements as to how well it works.

It would seem that the system is built, as one might say, on a system of "don'ts" and negations and it occurred to me that a few more merits scattered among the demerits for such acts as do not come as obligations for a gas fitter, but rather as a gratuitous service might be advisable, such as reporting new prospects, street leaks, gas thefts, etc., or even merits for exceptional service or performance of special duties might be allowed.

Also it occurred to me that if the same proficiency of inspection and checking necessary for the satisfactory working of this system were exercised with other systems very good results would be derived.

There is no serious question about a system which Mr. Kelley states has worked out so satisfactorily in the gigantic "Consolidated Gas Company of New York."

I can see no reason why the cardinal points—yes, and much of the same details of this system—cannot be copied for use in companies of all sizes where there are a dozen fitters, or more. Our problems of inspection, supervision and reports are much the same as in the larger company.

The main object of the system is to get something that the men will boost and co-operate with in making it a success. It is not a question of how many slips we can catch. In the ordinary way a foreman, or inspector would not consider it economical to follow up many of the items listed by Mr. Kelley, but it pays where a record is kept. For, as Mr. Kelley states, "a man always wants to be proud of his record."

It would be very interesting to know the "why" for all of these 340 errors, but this alone would make a very large paper.

I would also be interested in knowing how a man's standing is figured in percentage or demerits.

I congratulate Mr. Kelley on his excellent paper.

Mr. Kelley: Answering the criticism for penalizing men for assignment of wages, I would say that some years ago many of our men became entangled in the meshes of the loan shark. The men were bled freely and finally when they refused to pay more, the employees' wages were garnished and the company could not legally pay the employee the money he had earned. To overcome this all employees of the department who were in the toils of loan sharks were asked to make the fact known and the company offered the free services of its Legal Department to these men. They were saved from paying further exorbitant interest and had the cases closed by paying the principal only. All employees were then informed that in the future the assignment of wages by an employee would be considered a serious offence. The employees were further advised that a representative of the company's Legal Department would be at the general office one night each week and all employees who were in financial or other difficulty were invited to go to the general office for legal advice without charge. Now we rarely hear of any of our employees getting into the hands of loan sharks.

Mr. Cohn: Is the company loaning money in order to relieve his necessity?

Mr. Kelley: Up to about a year ago in special cases money was loaned by our Mutual Aid Society. Now when employees desire to borrow money they are referred to "The Morris Plan," which loans money at a legitimate rate of interest. We have had many cases where employees were ill and for a long period in a hospital paying to the hospital a weekly sum. The needs of the family required the full amount paid by the Mutual Aid Society and the company donated sufficient money to pay the hospital expenses.

Mr. P. L. King (San Antonio, Tex.): I would like to say that our company operates the gas, electric and street railway properties in San Antonio, and if the employee gets hard-up or needs money, has to have it, on account of sickness or for any deserving reason, by going to the vice-president of the company he can secure a loan from the company, and pay it back so much per pay day, and there is no interest charged the man.

The principal reason for starting this rule was on account of the fact that loan sharks were working very hard there and they would charge a man 100 per cent. interest, and in some cases more. The new rule has created a very loyal feeling towards the company; it is one of the things that has helped to increase the employee's allegiance towards the company, and the satisfied employee, of course, gives better service.

In regard to the merit system, I would like to mention the fact that we do not have a merit system in any department, but we have a bonus system, in the Bookkeeping and the Meter Reading Departments. For instance, in the Bookkeeping Department we pay a premium of $5 per month if the bookkeeper gets his balance in by a certain time and if he does not make over a certain number of errors; he is penalized according to the number of errors over four errors.

Mr. Kelley: The Consolidated Gas Company of New York does not offer any bonus for the number of indexes taken, but pays a bonus of 25¢ for every book indexed without an error. This bonus is paid on the first of the second month following the month in which the index was taken, thus allowing at least a full month for errors to become known.

MR. L. B. ELLIOTT (Chicago): Would it be out of place to ask Mr. Kelley what it costs him to maintain this record, or about how many men he would require in a shop of, say, fifty or sixty to keep a record of these demerits?

MR. KELLEY: The cost to keep the record is practically nil. We have in all of our shops what are known as "Ticket Readers." These men read all finished reports before they are returned to the office. At the same time they note the errors for which demerits should be imposed. The district foremen, the shop superintendent, and his assistant also note shortcomings which call for demerits.

Our costs have not increased in any way by reason of the merit system, nor are the services of any employee required any appreciable time to keep the record. In a shop of fifty or sixty men there would be practically no extra cost involved.

MR. ELLIOTT: One more question, Mr. Kelley: Do you make a final inspection on every job you do?

MR. KELLEY: No. In 99 per cent. of the cases the justice of the demerit is not questioned and the employee freely admits his error. If the employee questions the justice of the demerit, special means are taken to make it clear to him that the demerit was justified. If the offence was committed on the district, a district foreman would be detailed to go with the man and show him why he was demerited, if this was necessary, to satisfy the employee.

We like to have an employee question the justice of a demerit. It shows he is trying to avoid them, and if in any case there is the slightest possible doubt, the employee must have the full benefit of it.

MR. ELLIOTT: Is an inspection made of all your work?

MR. KELLEY: No.

MR. ELLIOTT: Then it may be possible that my work would never be inspected?

MR. KELLEY: Hardly; every man's work receives a certain amount of inspection. It should be admitted, however, no man's entire work is inspected and also that an employee may commit offences which should be demerited, but are not because we do not know of them. There are a lot of men out of jail who should be in, but we would not abolish jails for that reason.

Mr. Elliott: I have in mind that some poor fellow might get more demerits than some other fitter.

Mr. Kelley: That is true, but not unless he earns them.

Mr. Elliott: The man who gets the most inspection would get the most demerits.

Mr. Kelley: Yes, if his work warrants it, but no man's work is inspected to an undue extent for the sake of trying to fix demerits on him.

Mr. H. W. Peck (Schenectady, N. Y.): We have had the bonus system in our shop for a number of years, being based on the quantity of work rather than the quality, the quality coming in simply as a part of the demerit system. If reports are made of work being subnormal in quality or if in the routine inspection it is found to be subnormal, certain credits are taken away from the man. We feel that this plan encourages industry as well as good quality of work and is on the whole fairer to the men. Our system is such that a man earning about $16.50 a week, which is the average pay for first-class fitters, will earn on an average $1.80 a week in premium. That varies, of course, with different men, and is considered well worth while by the men.

We also have the bonus system in indexing which has been in force a little less than a year, but it has worked out exceedingly well. Our men have a fixed salary at the present time, based on the length of service which is the rate they were getting when we put this into effect. For all meters which they read they are credited 0.8 of a cent per meter. If this amounts to more than the fixed salary, as it does, I guess, in every case that has gone into effect, they get more money. For a man with a flat rate of $17 a week it naturally is harder to earn an excess than for the man of less length of service who is on a flat rate of $14. However, it is as valuable to the company to get 5,000 meters read by the one as by the other. We deduct 10 cents for every error in reading which is discovered. We also introduced something about two years ago, the scheme of reading meters only in the morning. We found on analysis that three-quarters of our re-reads were occasioned by calls to the premises in the afternoon. We figured we could eliminate that, and we have eliminated or reduced the number of re-reads to less than a quarter of what they formerly were by reading regularly only in the morning; and our men are now reading in the morning, under this merit system, as many meters as they used to read all day long. In the afternoon these men go on more or less special work. While we read in the country districts all day, others of the men go out in the country districts in the afternoon. Others go on re-reads or special reads or reading of prepayment meters. Some do clerical work inside. We are able in this way to keep our reading force busy in the afternoon as well as in the morning and at the same time it makes it rather easier on them. They do work good and hard in reading nearly two hundred meters every morning from 8 to 12, and we have had some men break down under the hard physical strain of reading meters. It may be especially hard in Sechenectady where 90 per cent. of our electric meters—we being a combination company—are in the attic and, of course, all the gas meters are in the cellar. It means much running up and down stairs. The city is rather closely built up on perhaps 35 or 40-foot lots. They walk up two flights of stairs and go down to the basement one flight again, which is pretty strenuous work.

I should like to refer briefly to the "Morris Plan" Mr. Kelley referred to. I think that is an excellent institution through which our employees can get help on a business-like basis. I am very interested to note, in looking over the list of directors of something like the fifty-seven of the "Morris Plan," companies that in almost every one there is one or more official of a public utility company on the directory.

MR. F. HELLEN (Rochester, N. Y.): I take some exceptions to what Mr. Peck says in regard to quantity and not quality. The question of a bonus system with us has been talked over considerably by the manager of our company. It has been put up to me to work out. I look upon it rather delicately. My ambition is to see how well I can do the work and then see how cheaply I can do it afterwards, because the first cost of doing the work does not come out of the earnings of the company. It is your maintenance afterwards. The best paid men we have to-day are the men who set gas meters. Our men who set the meters to-day understand the shop work thoroughly. After a meter is set he must inspect and adjust all appliances. The result of this is we have no after complaints. I doubt if we have had any complaints for over a year.

We first take up with them how good we can do the work, and second how cheap we can do it. One of my first efforts is to have the work done so well that the cost of maintenance afterwards will be small; and when you adopt your bonus system you will first save a few dollars. Your inspection has to be closer. I can readily see in reading gas meters and delivering bills it can be worked out to perfection.

Take the question of connecting heaters to a tank. It is no trouble for a man to connect three or four in a day if he does not want to look into the conditions of the tank and make a general inspection. I want to emphasize this one thing—let's not put too much thought on this bonus system. Let's put the thought on how well we can do the work. The same idea as to repairing gas meters. It is not how much will you save at the end of the month, but how good you can do it.

MR. KELLEY: Suggestions have been made for a bonus system covering the amount of work performed, but as yet we have done nothing along those lines. To have such a system it must be above all things absolutely fair to all. One might read a number of finished reports covering the same kind, and as far as the tickets would show the same quantity of work on the district, and yet the time required to execute the work would vary greatly in each case. Certain men are slow workers, but careful and neat—others are rapid workers, but careless and sloppy. I would welcome a system which would put a premium on quantity, and be absolutely fair to the young and to the old, to the heavy and to the lithe. Until such a system is devised, I should say—Quality always! Quality only!

We have many old employees, some 20 years, 30 years, or longer in the service. They are not physically able to get around and do the same amount of work as the youngster. I do not feel that they should be penalized or humiliated on account of their physical condition.

Mr. Peck: Mr. Chairman, I would like to say that is not fair to the men who naturally are more expert. Mr. Kelley will admit that there are some men, two particular men can be selected who will do equally careful and it may be equally good quality of work, and yet one because he is more adept will accomplish much more work than the other. In my judgment it is only fair that he should earn more. He is worth more to the company, and it is fair that he should be paid more than the other man.

Mr. Elliott: Do that by raising his salary. Do not wait for the bonus system.

Mr. Kelley: Answering that suggestion—yes, raise the wages, that is the true solution.

Mr. Hellen: On the question of this bonus system, when you go into it, go to a place where they are working it out, go to the men who are doing it and the men who are responsible for it in a way. Go to your foreman or assistant shop foreman, and see what they think of it. Do not try to put in a bonus system simply because some one else has done it. Go on the job, talk to the man who is doing the work and see what he thinks of it; inspect the work.

Mr. Peck: I extend a hearty invitation to anybody to visit Schenectady.

THE CHAIRMAN: We are thankful to Mr. Kelley for his very interesting paper.

THE CHAIRMAN: The next paper is one from Mr. F. H. Patterson, entitled, "Organizing for Cost Reduction in the Consumers' Bookkeeping Department," a paper that has entailed a great deal of labor, and I think you will feel amply repaid to hear it read.

ORGANIZING FOR COST REDUCTION IN THE CONSUMERS' BOOKKEEPING DEPARTMENT.

In order to appreciate the necessity for a revision of the methods employed in this department, a brief review of the plan previously in vogue, the difficulties which the company was encountering through a continuance of it, and the necessity of organizing to meet the demands of the company's business, which is becoming larger and more complex as the years go by, might serve to clarify the situation to some extent.

The business has grown to the point where the company now has approximately 95,000 accounts; consisting of 56,000 regular gas, 14,000 prepaid gas, 20,000 electric, 43 commercial steam and 5,000 merchandise or appliance accounts. The prepaid gas meters, it may be said in passing, are being systematically withdrawn from service and regular meters substituted therefor.

Each class of meter reading, bill delivery, collections, turning on and shutting off meters installed on consumers' premises, and the bookkeeping in connection with consumers' accounts were performed as separate operations. That is to say, to cite a particular case, the meter reading corps traversed the territory twice during a month to procure the gas and electric readings, while another corps usually consisting of different employees procured the prepaid readings. All of these employees were made available at various times for collecting and other work, so that there could be little attempt made at specialization which is essential to efficiency in operation. This duplication of effort, with its attendant cost and inconvenience to the public through numerous calls made, applied alike to such other functions as the collection of gas, electric and merchandise accounts independently, and in fact all other functions of the entire department as a natural corollary to such a separate departmental system. The meters were read between the 7th and the 27th of each month and accounts were payable at net amounts between the 1st and 15th of the following month. Employees performed all the work in connection with the consumers' ledgers, each one being responsible for as many ledgers as his or her ability would permit. It is, therefore, apparent that there were many peak loads borne within the office, and the congestion in the outer office was very marked during the paying period. A study of the company's methods further revealed the fact, that inasmuch as individuals were required to perform varied work, their efficiency could only be gauged by close personal contact, and therefore, their performances were unknown except to those immediately surrounding them. It was, therefore, almost impossible to determine whether employees were receiving salaries commensurate with the work they were performing, and the probability of their receiving increases of salary depended largely on the insistence with which they or others promoted their cases. Furthermore, the management was prompted by a desire to become familiar with the operations of this department in a more detailed manner in order to combat the problems arising within it and through its contact with the public. They rightly considered also that while costs and analyses of various kinds were prepared for all other departments, this one had been made largely immune except for the more general statements, despite the fact that not less than $100,000 was being expended in it annually. Our office space also (and this seems to be a chronic condition with all companies) was becoming badly congested. Under such a system, too, the duties of the chief clerk were necessarily onerous, his time being taken up with the disposal of many petty details which might more advantageously have been handled by others closer to the work, thus relieving him materially and making his time available for more important work. The inconvenience to the public was manifested monthly, by the large crowd of irritated consumers who appeared before the tellers' cages on the final date of payment to secure the net amount of bills.

SCOPE OF NEW PLAN.

The first logical step was the organization of a continuous meter reading plan by districts; one district a day for twenty-two days, thus permitting the work to flow into the Bookkeeping Department daily in amounts possible to dispose of within the day, and eliminating the peaks. As a continuous collection plan automatically follows continuous meter reading, the work of the department was immediately reduced to a daily basis thereby disposing of overtime work almost entirely. This was a formidable item under the old system in regard to such matters as balancing the books and preparing the sales statements. The plan embraced:

First—The organization of the employees of the department into groups governed by the nature of the work performed.

Second—The combination of separate but related activities within groups.

Third—The specialization of functions within groups, with the object of comparing the results of the work of individuals, thereby learning the efficiency of each. This latter requirement would naturally have as its corollary the government of proper remuneration, eligibility for promotion, or other benefits based on the actual merits of each employee.

PLAN OF ORGANIZATION.

The department was divided into eighteen groups according to the nature of the work conducted therein, and consists of the following:

Application Group.

Applications of consumers for gas and electric service, rate information and duplicate bills.

Credit Group.

Approval of the credit of the company's gas, electric, steam and merchandise consumers and the granting of extensions of time in connection with payments due on bills of this nature.

Order Group.

The issuance and execution of all orders pertaining to the turning on and shutting off of gas and electric meters and to the issuance of all orders pertaining to the setting and removing of gas and electric meters, together with the issuance of appliance orders.

Entry Order Group.

Entering of gas and electric turn-on and shut-off orders and set and removal orders on consumers' ledgers; the issuance of final gas and electric bills and the opening of new ledger accounts.

Addressograph and Printing Group.

The operation of the Montague machine in connection with the printing of addresses on gas and electric bills; the Typographic machine in connection with punching plates for use in the Montague machine; the hand addressograph in connection with preparing lists of consumers; the Multigraph machine in connection with linotype printing and the Mimeograph in connection with stencil printing. Some of the activities of this group are of a general character and do not wholly pertain to the operation of the Consumers' Bookkeeping Department, but in the preparation of statements that part which is irrelevant is segregated therefrom.

Meter Reading Group.

Prepaid Meter Reading Group.—The reading of gas prepaid meters and collections in connection therewith.

Regular Gas and Electric Meter Reading Group.—The reading of regular gas and electric meters.

The company is engaged in consolidating the prepaid and regular gas and electric meter reading records so that all three classes of meters will be read indiscriminately by a meter reader on each route instead of requiring the services of a separate corps to take the readings and make the collections of the prepaid meters independent of the regular gas and electric meters. Reference has been made in the foregoing part of this paper, however, to the fact that prepaid meters will shortly be practically a negligible quantity with this company.

Billing Group.

The preparing and issuing of the gas and electric bills to municipalities for services in schools, fire houses and other public institutions, street lighting and regular gas and electric bills, also data and bills in connection with the company's power consumers.

Bill Delivery Group.

The delivery of gas, electric and appliance bills.

At the present time, this corps is a combination bill delivery and collection corps as they are required to stop at each door and give the consumer an opportunity to pay if he so desires.

This group, together with the Prepaid Meter Reading Group and the Regular Gas and Electric Meter Reading Group are all under the supervision of one man.

Regular Ledger Keepers Group.

(*a*) Posting of debits to the consumers' ledgers.
(*b*) Listing and sorting of coupons.
(*c*) Posting of cash and allowances.
(*d*) Listing of sales.
(*e*) Listing of delinquents.
(*f*) Balancing of ledgers.

The posting of cash is done exclusively at night by a corps of employees who report for duty at 12 o'clock midnight and work until 8 A. M. except Saturdays, when their hours are from 2 P. M. until 6 P. M. The reason for this innovation was primarily to have the accounts and delinquent list credited with all cash receipts of the previous day and available for use by the other departments, and secondly, to reduce the congestion in the department, by eliminating this particular corps of workers in the daytime.

Gas Prepaid Ledger Keepers Group.

The debit and credit posting and balancing in connection with Prepaid Ledger Group proper.

As the prepaid meters are rapidly being eliminated, this department is left for the time being as it has always been conducted. Such prepaid meter accounts as continue to remain open will be absorbed into the regular Ledger Keepers Group referred to above.

Collection Group.

The collection of gas, electric, steam and merchandise accounts including the issuance of first, second and final notices to delinquent consumers.

Delayed, Estimated and Mailed Bills Group.

The issuance of delayed and estimated gas and electric bills and the mailing of all bills with special addresses.

Complaint Group.

The receipt and disposal of all complaints received from the public.

Tabulating Group.

The operation of the Hollerith punching, sorting and tabulating machines in connection with the distribution of gas, electric and merchandise sales to the proper accounts prescribed by the Public Service Commission and by tax districts for the State Board of Tax Commissioners; the preparation of a statement of the quantities of gas and electric current sold at our various rates; the preparation of statements showing the total number of the various size gas and electric bills issued; the preparation of a statement of the sales of gas and electric current according to the nature of business supplied, and finally the automatic checking of all extensions of gas and electric bills before they are sent out.

Appliance Group.

The posting of debits, the listing and sorting of coupons, the posting of cash and allowances, the listing of sales and the balancing of merchandise or appliance ledger accounts.

Relief Group.

It early became apparent, after the organization of the system, that in order to keep the employees of the various groups engaged up to their fullest capacity, it would be necessary to furnish only sufficient help to complete the work each day under normal conditions and at the same time it could not be expected that all employees would work every day of the year, because of sickness, vacations and other reasons for absence. In consequence of this, the natural solution was the formation of this group, the supervisor of which has under his authority a sufficient number of employees to supply vacancies in any of the other groups. In addition, he is expected to perform all abnormal requirements which arise from time to time in the department, such as the rewriting of meter read slips. This particular work, which has just been completed, involved the preparation of about 90,000 regular gas, electric and prepaid meter slips. At the same time, he was required to prepare a set of accounts of a like number, partly because our old ledgers, which were circumscribed by having the year and month printed on each account, had reached their limit, and also because the accounts had to be opened on the combination gas and electric form newly adopted. Obviously, as the employees engaged on regular work are supposed to be occupied the entire time, this work necessarily devolved upon the Relief Group. When such abnormal matters come up for disposal, it is customary to provide additional temporary help, as the management is opposed to employees working overtime. Such additional employees are, however, relieved of their duties immediately after the work has been completed. In the meantime, they stand in the Relief Group branch of the monthly report, constantly under the eye of the management, who naturally want to know whether the amount of labor performed by the group is commensurate with the number employed therein.

Occasionally it becomes necessary to transfer employees from one group to another, temporarily. When this is done, the supervisor of the group permitting the transfer is required to keep a record, on a form known as "Time Spent in Other Groups and Departments," so that each group may be charged with its actual labor cost during the month. It is contemplated, however, to restrict all such transfers, as nearly as possible, to the Relief Group.

Supervision and Miscellaneous.

The chief clerk is in charge of the entire department, assuming all responsibility in connection therewith. He has as his immediate assistants the assistant chief clerk, stenographer and statistical clerk, who are classed under this one general head, and this represents in a sense, the indirect expense of the department.

At the head of each group, having all others in that group under his authority, is a working supervisor who is expected to have sufficient knowledge to discharge any of the functions of his group's activities, and to be able to answer any of the questions arising within the group. The object of this arrangement is twofold; first, that the chief clerk of the entire department may be relieved of many petty duties and, second, that men occupying these positions may be trained to higher executive positions by having different responsibilities thrust upon them. It is further contemplated that these supervisory positions be graded according to the responsibilities and work involved, and with salaries commensurate thereto, with a view to providing promotions for supervisors from the lower grades to the higher as future circumstances require.

The company has chosen certain units applicable to the activities of each group and when statements of the cost of the department by groups are prepared at the close of the month, the cost per unit is worked out to provide a comparison with the work of previous months, and as time goes on, the two corresponding periods of different years. This is susceptible of even finer analysis within most of the groups. As an instance, the case of the Entry Order Group may be cited, wherein a record of the number of orders completed by each clerk is kept, the cost per order for each determined, and an individual comparison made of the performances of all employees engaged on this work. Annexed to this paper, is a form of statement (Exhibit No. 2) showing the names of the groups, the unit employed in connection with each, and a space assigned for entering the number of units of work accomplished and the cost per unit for the two periods under review. Each of these groups has a separate schedule supporting the figures shown as its total cost in the monthly report, giving for each of the employees of the group the number of units of work they have produced, the salary paid, and the labor cost per unit, where practicable.

At the back of each ledger a sheet, ruled in columnar form, has been inserted having as captions the names of the various functions necessary for writing up and balancing a ledger. As an employee completes a piece of work, he is required to turn to this sheet and insert his initials and date of completion of the work under the appropriate caption. In this manner, errors afterwards discovered can be traced to the employees making them.

This automatically provides the merit system by which employees shall receive consideration at various times.

It may be well to mention that the merchandise accounts have not been combined with the gas and electric accounts in one ledger. I know the practice of most of the large companies is to include these in the same ledger with the gas and electric accounts, but there are also disadvantages in so doing and as a limited number of employees can readily execute all the work in this connection, the company has kept this group separate from the gas and electric ledger keepers.

COMBINATION OF RELATED ACTIVITIES WITHIN GROUPS.

All related work was classified and segregated into the respective groups and included such matters as the consumers' applications for service on a combination gas and electric form; the issuance of combination meter orders; the reading of gas and electric meters in combination; the use of combination ledgers; delinquent lists; tabulating cards and other combination forms. This plan is directly opposed to the method of handling each department as an independent unit. It has required the educating of employees to perform gas and electric work in each group indiscriminately, thus broadening their knowledge of the operations of the groups.

SPECIALIZATION OF FUNCTIONS.

Such a system as is here explained carries with it opportunities for the specialization of functions and admits of statements of comparison of results achieved by the individuals in the groups. This in turn results in obtaining the maximum degree of effort by each individual on each function. As an instance, the case of men engaged in turning on and shutting off meters already installed, under the authority of the supervisor of the Order Department, may be cited, wherein this idea has been carried out very successfully. A corps of eight men was required for this work when the system was first inaugurated, but since that time two men have been eliminated and transferred to departments requiring them, while a third employee acts merely as a relief man. The remaining five employees are successfully performing the work required. This is again true in connection with the entering of orders on the ledgers in the Entry Order Department, wherein four employees were required to perform the work of the department at the outset, and three are now satisfactorily accomplishing it. Similar individual comparison forms have been provided for gas, electric and prepaid meter readers, the employees of the Billing Department, the bill deliverers, ledger keepers, collectors and for the employees of the Tabulating Department. The various units employed are set forth in the appended statement (Exhibit No. 2).

It would be impracticable to include in this article reproductions of the various subsidiary and summary forms employed to exhibit the operations of the groups, but a typical one (Exhibit No. 1) is presented, representing that used by the Regular Meter Reading Group and which, it is hoped, will convey the ideas embodied in the forms used in other groups.

In connection with the reading of meters also, a bonus system of payment has been inaugurated. A flat rate salary of $14.00 per week is paid each man and in addition he is permitted to earn ¾ of 1 cent for each meter read above a certain standard set for each route for the month.

Through a study of the Billing Group, we have also installed a Burroughs subtracting machine which automatically prints the dates and index amounts of the first and second readings and makes the subtraction in each case. The Todd machine, a new device on the market, places the gross, discount and net amounts thereon in the same manner as would a check writer, thus completing the bill. The postings to the ledgers are now made on the Burroughs posting machine which posts and automatically lists the sales entered on the consumers' ledgers.

Results Achieved from the Installation of the New System.

By the inauguration of this system, the department operations—complex as a whole but divisible into simple units—have been made comparatively plain for the benefit of the management, who are unable to give the time to a detailed study of it and who, heretofore, were absolutely dependent on more general statements regarding its performances. They have thus obtained a broader knowledge of the company's activities and can, with the information obtained, meet the problems which this department's contact with the public produces.

One of the paramount benefits obtained—the value of which will improve as the years go by—has been the education of employees as supervisors, whereby they gain a knowledge to enable them to fill the higher executive positions for which it is usually so difficult to obtain competent help. These supervisors, too, now dispose of all routine matters and petty details in connection with their work which heretofore has, to a large extent, been required of the chief clerk. This official now has the necessary time to devote to matters of broader policy, the obtaining of greater efficiency and the development of labor saving methods, to say nothing of the salutary effect produced by his being able to pass from one group to another two or three times a day to ascertain how the work is progressing.

By the elimination of the peak loads, which necessarily obtained under the old system, the work is now passed through the department daily and disposes of any necessity for overtime employment, which is detrimental physically to the employees and gradually grows to be a financial burden to the company. This, too, permits of steady and constant work on the part of each employee.

By this study of the functions of the various groups, it early became apparent that the duties of some clerks did not coincide with the regulation hours of the company. For instance, the clerks engaged in the sorting of cash stubs were practically idle during the first hour of the day before consumers had commenced paying their bills, but were busy for an hour after the office had closed, sorting and tabulating the tickets which had come in up to the hour of closing. It was, therefore, obviously the proper plan to have these clerks report for duty one hour later in the morning and leave one hour later at night. This refers to the sorting of cash tickets to prove the tellers' cash for the day. In addition, the tickets must be sorted by ledgers for the use of the employees who post cash and who report for duty at 12 o'clock midnight. Therefore, the hours of the employee engaged on this latter class of sorting begin at 4 o'clock in the afternoon and end about midnight. Similarly, to keep the machines of the Tabulating Department busily engaged for the fullest possible time, thereby obtaining as good a load factor as possible, and also to eliminate the distracting noise of such machines as the Hollerith sorting machine, the hours of the employee engaged on this work are largely spent in the evening.

Reference also has been made to the night corps engaged with the duty of posting cash credits to the ledgers, thereby keeping the books constantly up to date and enabling the delinquent sheets to be prepared promptly.

All the innovations here referred to have been planned largely with the object of eliminating overtime payroll, and the results achieved in this connection are most gratifying, as is shown by the decreased cost of operating the department.

Errors have been reduced almost to a minimum by keeping a record of the kinds made and by whom, thereby fixing the responsibility and permitting an accurate analysis to be made with a view to further reducing their number. This will result in eliminating the causes of friction with the public and will promote more cordial relations. It has been effected to a large degree by the establishment of a Complaint Group physically separate from all other groups and well equipped with glass enclosed gas and electric meters, maximum demand and other meters for the education of the public. The physical separation of the Complaint from the Application Group, where the operations were formerly carried on jointly, has resulted in the keeping of new applicants for service apart from complaining consumers, the psychological effect of which must have been detrimental to the company's interests. Through a study of the Complaint and Application Groups, various charts have been produced showing the busy and comparatively idle hours of these groups and has resulted in a more intelligent study of their needs.

The hours of the employees of the Application Group have also been changed so as to bring the greatest strength of this group to bear on the peak demands of the day, and to offset the limited noon hour provided in some cases, employees are permitted to arrive later in the morning or leave earlier at night.

The inauguration of an automatic follow-up system to insure the rendering of bills according to a prearranged schedule places the responsibility for any delay at the door of the proper employee.

By requiring the employees to work on both gas and electric matters in their respective groups, indiscriminately, the result must be a distinct improvement in the type of employees produced as opposed to that of the old system. The advantage to the company here lies in having several employees capable of performing any duty within each group. In addition, by specialization, all functions have been rendered comparatively simple and extensive training is not required to perform the work.

Under this plan, the primary benefit accrues from a study of the monthly reports enabling the management to make intelligent decisions with promptitude as to increases of salary, promotions and other benefits to employees and automatically eliminating favoritism and the complaints of employees as to the proper amounts of remuneration due for services performed as compared with their colleagues. The monthly report of work performed for the department as a whole, for the various groups, and for individuals within groups compared with previous months or with corresponding months of previous years, must necessarily result in the elimination of waste of effort and the obtaining of a higher degree of efficiency in the entire department. In fact, the company regards the production of this detail report of paramount interest, as it sums up monthly in logical form, the result of the operations of the department as a whole and by constituent groups.

This article would not be complete without at least a brief explanation of the bookkeeping methods employed in the department. This I have separated into two divisions, bookkeeping applicable to gas and electric consumers' accounts and that applicable to appliance or merchandise accounts.

Bookkeeping Applicable to Gas and Electric Consumers' Accounts.

Combination ledger accounts of these branches are prepared by the Entry Order Group from the completed orders received from the Order Group.

The gas and electric bills originate in the Addressograph and Printing Group where the names and addresses, codes for Tabulating Department, dates of issue and due dates are printed thereon. They are forwarded to the Billing Department where they lie idle pending receipt of the meter readings for the particular district being read.

The gas and electric meter read slips enclosed in binders by routes are, when read, forwarded to the billing clerk in the Billing Department. The dates of the current and previous readings together with the registrations for each date and the subtractions are recorded on the bills by means of the Burroughs subtracting machines. The bills then pass to the clerk operating the Todd billing machines who stamps the gross, discount and net amounts on the bills and stubs at one operation for each bill. They then pass to the debit posters who enter on the ledger sheets by means of the Burroughs posting machines, the dates, index, discount or penalty, consumption and net amounts. The arrears are then placed on the bills and the totals computed and entered thereon.

The posting machines automatically list and add the gas and electric bills separately and these lists together with the bills are forwarded to the Tabulating Group. After punching cards from the coding on the bills, this group first proves the extensions on all bills by sorting and tabulating the cards according to the various rates, and ascertaining the products obtained by employing the proper rates in each case. As the tabulated totals for each rate class should equal the product obtained by multiplying the total consumption for each class by the proper rate, errors in extensions are thereby quickly eliminated. The Tabulating Group also make the distribution of the sales to conform with the requirements of the Public Service Commission accounting classification, the distribution of sales according to tax districts and other data to which I have previously referred. This completes the regular gas and electric bills which pass to the Appliance Group where the appliance monthly statements for the district are sorted into the proper order. They are then forwarded to the Bill Delivery Group for distribution.

The large electric and gas bills and municipal street lighting bills must necessarily receive special attention which is given by the Billing Group, with the assistance of the Engineering Department. The order of routine, therefore, in these cases varies slightly on that account.

The readings being taken by districts, it naturally follows that the sales are tabulated and distributed by districts and a monthly report is furnished by the Tabulating Group from which the necessary journal entries are made placing them on the general books. The cash is received by districts, one day being assigned to each district except in cases where Saturdays or holidays intervene, when the cash from two to three districts may be received in one day.

The ledgers consist of from five hundred to seven hundred and fifty accounts and are self-balancing, the result of the month's work being summarized in each case on the balance sheet inserted at the back of each. A reproduction of this form (Exhibit No. 3) is included herein.

Bookkeeping Applicable to Appliance or Merchandise Accounts.

The accounts in this connection are kept separate from the gas and electric consumers' accounts, although you will notice provision has been made on the balance sheet for their inclusion. It was deemed advisable not to merge them, however.

The debits to these accounts originate in the Order Department from the completed orders; extensions, additions, coding for tabulating and other relative information being placed on them by the employees of this group. The amounts are posted to the debit of the various accounts, an adding machine list is prepared and the completed orders are sent with the adding machine list to the Tabulating Group where the distributions to the proper general ledger accounts are made, as nearly as may be, daily. The summary of these daily distributions furnishes the data necessary at the close of the month for the journal entry to place the amounts to the credit of the various merchandise sales and other accounts and the concurrent debit to the accounts receivable. Allowances originate in the various departments and, having been reviewed by the auditor, are credited to the accounts in these ledgers and distribution summaries are prepared by the Tabulating Group for entry in the general ledgers. The cash is credited through the medium of the stubs cut from the bills when payment is made and must, of course, be in agreement in total with the cash book column assigned to these receipts. Each of the ledgers in this group is also self-balancing.

This system, at the present time, is in process of installation and all the ideas ascertained by a study of this department have not been placed in practice. One of the greatest benefits, from the viewpoint of saving effected, is expected to come through a consolidation of the Consumers' Bookkeeping Department and the General Auditing Department in one room under the direct supervision of the auditor. Heretofore, an artificial separation has been maintained by keeping the Consumers' Bookkeeping Department in a different part of the office, and entailing the losses usually suffered from segregation as opposed to centralization.

LABOR COST SUMMARY AND STATISTICS OF METER READERS' GROUP

Exhibit No. 1

Route No.	Employee	Days Out	Number Meters on Route		Standard For		Number Meters Read		Time per			Number Missed	% of Meters	Errors	Salary			Cost per Read	C
			Regular	Prepaid	Route	Day	Month	Day	Route	Day	Meter				Regular	Bonus	Total		
	Regular Meter Readers																		
	TOTALS																		
	Pick Up and Relief																		
	TOTALS																		
	Supervision																		
	TOTALS																		
	GRAND TOTALS																		

"C" in last column denotes those routes wherein prepaid and regular meters have been combined.

COMPARATIVE MONTHLY LABOR COST SUMMARY AND STATISTICS OF CONSUMERS' BOOKKEEPING DEPT. BY GROUPS Exhibit No 2.

Group Name	Month of 191				Month of 191				Increase (Decrease in Red)				Unit Employed
	Unit	Labor Cost		Cost per Unit	Unit	Labor Cost		Cost per Unit	Unit	Labor Cost		Cost per Unit	
Application													No. calls at counter
Credit													No. items passed upon
Order													No. orders completed
Order Entry													No. orders entered
Addressograph													No. regular gas & electric meters
Meter Reading	* * *	* *	*	* * *	* * *	* *	*	* * *	*	*	*	* *	
Regular Gas & Electric													No. meters read (regular)
Prepaid Gas													No. meters read (prepaid)
Total													No. meters read all classes
Billing													No. regular gas & electric meters
Bill Delivery													No. bills delivered
Regular Gas & Electric Ledger Keepers	* * *	* *	*	* * *	* * *	* *	*	* * *	*	*	*	* *	
Debit Posters													No. accounts
Sales Listers													No. bills rendered
Coupon Sorters													No. coupons
Credit Posters													No. credits posted
Balancers													No. regular gas & electric meters
Prepaid Gas Ledger Keepers													No. prepaid gas accounts
Total													No. accounts—Regular gas, electric and prepaid
Appliance and Miscellaneous Sales													No. charges and credits
Collection													No. delinquent accounts
Tabulating													No. cards handled
Delayed, Estimated and Mailed Bills													No. items handled
Cashiers													No. bill coupons paid
Complaint													No. complaints handled
Relief													Various—According to work
Supervision and Miscellaneous													Total No. accounts all classes
Total Entire Department													Total No. accounts all classes
Deduct Relief Department	* * *			* * *	* * *			* * *	*			* *	
Normal Cost Entire Department													Total No. accounts all classes

ROCHESTER RAILWAY & LIGHT CO. Exhibit No. 3

Balance Sheet 19

Date	Cash	*Allowances	Discount or Penalty		Bills Paid Twice or Overpaid	†Bad Debts Paid		**Dr.**				
			Gas	Electric								
								BALANCES;				
								Gas				
								Electric				
								Appliance				
								SALES:				
								Gas				
								Electric				
								Appliance				
								ADDITIONAL SALES:				
								Gas				
								Electric				
								Appliance				
								TOTAL DEBITS				
								Cr.				
								Cash				
								ALLOWANCES:				
								Gas				
								Electric				
								Appliance				
								OUTSTANDING:				
								Gas				
								Electric				
								Appliance				
								TOTAL CREDITS				

* Analyze according to Gas, Electric or Appliance in Allowance Record.
† Indicate whether Gas, Electric or Appliance by prefix G. E. or A.

THE CHAIRMAN: I might state, in connection with Mr. Patterson's paper, that we have a number of written discussions here, and I was wondering what the feeling would be, whether it would be preferable to have the oral discussion first. The criticism was made that possibly having too many written discussions read might discourage the oral discussions; that was not the intention. I would like to hear from the members as to how they feel on this subject.

MR. C. M. COHN (Baltimore, Md.): I think the discussion should be opened by an oral discussion, besides having the written one read.

THE CHAIRMAN: If that is agreeable, we will assume that is the sentiment of the meeting. I am sure Mr. Patterson is entitled to thanks for his painstaking efforts on this very valuable paper. We would be very glad to hear any discussion.

MR. V. L. ELBERT (St. Joseph, Mo.): I think we should have those written discussions read, and have an opportunity to go back to anything he may think of, or have a chance before they are published.

THE CHAIRMAN: Mr. Patterson will have access to the written discussions before we close the record.

MR. EWALD HAASE (Milwaukee): Mr. Chairman, I would like to ask Mr. Patterson whether he has found that the comparative monthly labor cost summary and statistics have been of such value in estimating the value of the employee's services as was expected? Is not the volume of work done by a great many office employees dependent largely upon the rate at which that volume of work presents itself to them, the taking of applications, the writing of orders, and things of that kind?

MR. F. H. PATTERSON (Rochester, N. Y.): We have endeavored to so lay out the work as to have and to include in these groups just a sufficient number of employees to perform the work as it comes through, and they are supposed to be all working up to capacity practically at all times. For instance, the clerks on entering orders and opening up new ledger accounts always have a day's work ahead of them; in fact, probably two or three days' work, and can be kept constantly busy at all times.

Meter reading and matters of that kind work out automatically. Our billing is performed day by day. We have just enough employees in that group, or any group, to perform the work in it. If one happens to stay away, or is sick, then it is necessary to throw in a relief clerk to help get the work out.

MR. HAASE: Mr. Chairman, may I amplify my question by referring to such work as goes with the ups and downs of the business; more consumers, or prospective consumers, present themselves at the application windows on or about the 1st of May than on or about the 1st of February; at certain times of the year we are selling more appliances and in consequence issuing more appliance orders. I thought more of the seasonable work when I spoke.

MR. PATTERSON: It does become necessary in the months of May and October, in our locality, to have more than the regular force on the application counter. In that case it is necessary to provide a man to assist at that point. The relief department absorbs all such extraordinary jolts.

We have also studied the application counter with a view to learning how many items are passed over the counter day by day, week by week and month by month, so that we can tell when our peak load occurs, in the daytime, morning and afternoon, and on what days of the month they usually occur. That, we find is always on a Monday. We also learn when seasonal changes occur, such as in May and October. The ordinary fluctuations occurring through the day are taken care of by the department by a little extra spurt, and the seasonal ones are taken care of by the relief department furnishing a man who is particularly adept at that work.

MR. H. B. REINACH (New York City): I would like to ask Mr. Patterson whether these are permanent employees of the company?

MR. PATTERSON: Yes, they are.

MR. REINACH: What do they do when that relief is not needed?

MR. PATTERSON: There is always a certain percentage of employees out on account of sickness or vacations, or some other cause of absence.

MR. REINACH: Always?

MR. PATTERSON: Yes; every day you can count on some one being absent. We have about 160 employees in these different groups. We can bank on somebody being absent almost every day. But to employ their time when the relief corps is not busy, the members are sent around into other departments and taught the use of the phones and the application counter, complaints, and so on, so as to make them more valuable when the time arises for their help.

MR. REINACH: Are they junior clerks?

MR. PATTERSON: No.

MR. REINACH: What do you call junior clerks?

MR. PATTERSON: We have one very competent man in charge, and he has a whole corps of men under him—not very many, four or five all told, and they range from fairly good clerks down to junior clerks.

MR. REINACH: Four or five clerks?

MR. PATTERSON: Yes; constituting that group at the present time. But when we had to rewrite all the meter slips we had quite a relief department—ten people possibly at that time.

MR. REINACH: And these people are kept busy practically all the year around?

MR. PATTERSON: Practically all the year around.

MR. REINACH: Thank you.

MR. A. M. BARNES (Cambridge, Mass.): I take it, from Mr. Patterson's paper, that it applies to a very large company, and he has already stated that it is a combination gas and electric company, but he has not answered all the questions asked. It would be interesting to know (if he can give me the information) the average number of meters which each meter-reader takes in a day, either gas separately or gas and electric, and the number of prepaid meters which each prepaid meter-reader or collector takes charge of per day. In his application department, has he any system for dividing the applications as to territory or alphabetically? How many clerks are employed at the application department, and how is their work divided? Is it divided systematically, or do they take them as they come in order? One other question about the meter-readers. Do they deliver the bills? And, leaving out the meter-readers, can he tell me about how many meters—how many accounts, either gas or electric, each clerk would average? For instance, if he had ten clerks and ten thousand accounts, that would average about one thousand per clerk.

One other question occurs to me, in regard to putting the amount of the bills by the Burroughs machine. I understand from his paper that subsequently those bills are turned over to the billing department and the over-due amount is added on the bill. Whether he has any complications arising from the fact that the bill states the net amount of the current bill and the over-due amount; whether any complications arise from that feature of the system?

MR. PATTERSON: I have a record of the meter-readers in front of me for July, in which case one man read as high as 291 meters every day during that month. The next highest being 285, and the average for all meter-readers on regular meter reading, but not pick-ups, was 253 meters per man per day for the entire month.

Our meter-readers do not deliver bills. We have tried to specialize. We keep all our 13 regular meter-readers at meter reading continuously. We have got our town districted so that there are 22 districts and they are read on 22 days in the month. They also read on Saturday mornings. That time is employed to give the readers a little start on the next district.

Our bill deliveries are separate and distinct, and they deliver about 425 bills per man per day during the entire month at the present time. For a while they were required to knock or ring at the door and ask if the consumer wished to pay the bill; but we found that only about 2 per cent. wished to pay at the time the bill was delivered, so we have discontinued that. Now, they are required to stop and knock or ring only when it states on the bill "to collect."

In regard to the application department, there are five people employed on that desk all the time, and they handle numerous things like the applications proper, gas and electric, and such matters as requests for duplicate bills—simply the request, and it is sent on into the duplicate bill clerk who makes out the duplicate bill; and any other information such as complaints of gas leaks and so on. They do all that work indiscriminately. There is no classification of the work by clerks. Did I get all your points? My memory is pretty short.

MR. BARNES: Do they take the applications as they come along?

MR. PATTERSON: Yes, indiscriminately.

MR. BARNES: Whether or not you had any trouble arising with the public from adding on the over-due amount at the bottom of the net discount bill?

MR. PATTERSON: Well, occasionally we make errors, of course. But an effort is made to eliminate all arrears items from the bills before they go out; and that is done by the night posters who prepare a list of all arrears that are paid, and it is sent to the meter-reading department. The meter-reading department also looks after the bill delivery; they are all under the same supervisor, and he is required to cut off those arrears that have been added on the bills and which have been paid during the previous day. In other words, our arrears are checked off the bills up to within almost a day of delivery; and I think a great deal of friction has been eliminated by that. We used to have a great deal of trouble in this connection.

MR. BARNES: Perhaps I will make my point a little clearer if I cite my own experience. We tried that same system for a while, and we found several people were sending in their checks for the net amount of the current bill, leaving the overdue part off. So we have started this system: When the billing department finds there is an over-due amount, the machine stamping is not used, but the gross amount of the bill is put on. Then the over-due amount is added; and the amount of discount if paid on or before such and such a date, is placed on one side and deducted when the bill is presented for payment.

Mr. Patterson: We try to take care of those cases when they occur. If a check comes in short, we take care of it right there and then either by mailing it out or sending out a collector to collect the difference in amount.

Mr. Barnes: I was curious to know whether you have a great deal of trouble with it.

Mr. Patterson: Not a great deal, no. Now, in relation to the number of accounts that the clerks handle, our work is segregated, so that we have debit posters doing debit posting all the time, and credit posters doing the credit posting, and so on. The clerks on the subtracting machines enter the first and second readings, and the machine automatically makes the deduction. They do an average of about 200 an hour, or about 1,600 a day. It is quite a simple operation. It operates exactly like an adding machine. And in relation to debit posting, that has been made quite simple by preparing the bill completely before it reaches the debit posters, so that all they have to do is enter the results there, and they get out about 2,000 a day each. They are men who have been trained to the work.

Mr. Barnes: Well, you will answer my question a little more explicitly if you will give me the total number of clerks and the total number of accounts.

Mr. Patterson: Well, we have at the present time about 98,000 accounts, all told, and we have about 160 employees. That is, handling everything from the receipt of the application until the inevitable complaint has come in, and including turning on and shutting off meters.

Mr. Barnes: And your clients are properly satisfied?

Mr. Patterson: Yes.

Mr. C. M. Cohn: What is the maximum number of days that elapse between the reading of the meter and the rendition of the bill?

Mr. Patterson: We planned to make it about 5 days; that is the schedule. We mail a pre-arranged schedule at the beginning of each month. The bills are supposed to be rendered 5 days after the meter reading.

Mr. P. L. King (San Antonio): I would like to ask how many days between the time of the delivery, or at least from the time of the reading until the discount elapses. Ten days, is that it?

Mr. Patterson: Ten days. We get the reading, and then 5 days are allowed to elapse before the bill is sent out, then 10 days after that. So we have 15 days from the date of the reading.

Mr. King: Does a consumer get his bill at exactly the same period each month? Do you have any trouble by a consumer kicking about getting it at a different time from that of the previous month?

Mr. Patterson: No.; that will run from 12 to 17 days, as a matter of fact. There has not been any great trouble over it.

Mr. King: In the business section do you arrange it so that the business houses will pay their bills mostly between the 1st and the 10th, or do you just treat them as you do the residences?

Mr. Patterson: We treat them the same.

Mr. H. B. Lohmeyer (Baltimore): Mr. Patterson, you just mentioned a few moments ago that you handle 2,000 accounts debit posting. Would you mind stating just what information is posted on your ledger by the Burroughs posting machine?

Mr. Patterson: Yes; I have a ledger form here, if you are interested in seeing it (producing ledger form). It is a combination form; and gas accounts are entered on one side and the electric accounts on the other; the gas on the left hand side, and the electric on the right. Of course, while we are a combination concern, we as a matter of fact only have about 13,000 combination accounts. Under the gas division we enter the first and second readings, the discount or penalty, the gas consumption, and the amount; and on the electric side we enter the date, index, discount and penalty, electric consumption and kilowatt hours, and the amount.

MR. LOHMEYER: You mean an electric and gas customer counts as one?

MR. PATTERSON: As one. But there are only about 13,000 out of a total of about 80,000 customers, altogether; that is, 80,000 gas-electric customers; we have practically 10,000 prepaid gas meter accounts, which, of course, do not come into this.

MR. LOHMEYER: What type of Burroughs do you use, a duplex?

MR. PATTERSON: It is a new machine they have placed on the market recently. It is a specially built machine, made in their Detroit factory for our particular needs.

MR. S. M. WHITWELL (Washington, D. C.): I would like to ask Mr. Patterson if your company has any outside arrangements for the collection of gas bills?

MR. PATTERSON: None whatever. They all come to the main office.

MR. WHITWELL: We have been able to have an arrangement in Washington that we have not heard of being in operation in any other city, which works very well with us. We have some nineteen or twenty banks and trust companies which collect our bills for us without any charge whatever to the company, with the arrangement, except during dividend periods; months when we have to pay dividends and need large amounts of money, and during the tax-paying month. we are supposed to leave a balance there of one-half of what they collect and let that accumulate up to any of those periods I have named. We have found we have been able to cut down our number of cashiers materially, and that it also cuts off a very large number of complaints that would naturally come into the office from the people who hear others make complaint when they come there to pay their bills. It is a suggestion I offer.

Mr. Patterson: I think the principal reason why the management of our company is desirous of having the payments made at the main office is to draw the people to that point, with a view to seeing what merchandise we have for sale; and since we have adopted this continuous paying method, one district a day for each day in the month, there is no congestion in the outer office, and the work is handled by five tellers.

Mr. Barnes: I would like to ask if he has any complaints from those who have bills at their places of business which do not go out on the same date as the bills for their residences?

Mr. Patterson: We had a little friction on that point, but we have eliminated it by asking him to give us his business address so we may mail his residence bill, and he pays in two checks instead of one as formerly. We have no friction now; but we had some in months past.

Mr Barnes: Mr. Patterson has the advantage of having a combination company. If he were an independent gas company he might have some difficulty in carrying out some of these things.

Mr. Lohmeyer: In connection with the consumers' accounts we have used the group system in our company, both combined and with gas and electric groups separate. We find it works as well separate as combined.

Mr. Patterson: I must acknowledge that before this system was really inaugurated, the Consolidated Gas & Electric Company of Baltimore had really installed it and we borrowed their brains in establishing it in Rochester.

The Chairman: If there are no further discussions, we might have the Secretary read the written contributions.

Mr. Cohn: I would like to suggest, Mr. Patterson, that you some time drop in to see us. We have made some improvement in our system.

MR. PATTERSON: I think we could gain a lot of useful information, and probably it would be worth while.

THE SECRETARY: (Reading.)

MR. DEWITT CLINTON (Worcester, Mass.): (Written discussion communicated.) If all who have listened to Mr. Patterson's excellent paper on "Organizing for Cost Reduction in the Consumers' Bookkeeping Department" could have the opportunity to visualize the workings of the system described. our admiration for the system so clearly set forth in the paper could not help but be increased and strengthened.

There comes a time in every successful growing business when the old methods, which were good and sufficient at the beginning, become antiquated and insufficient and the demand for simpler, easier and more systematic methods becomes imperative. Seldom, I think, however, has more hard work, study and thought been put upon improving and organizing for new methods in the Consumers' Department of any lighting company as was given in the Rochester Company by Mr. Patterson and his associates. It is evident that they have delved into every nook and cranny, studied every phase of the question, correlated the information and evolved an admirable system. The writer was fortunate enough to be privileged to visit Rochester just about the time the new system was being put in operation and he is glad to voice here the approval and admiration which he expressed at that time.

It was undoubtedly not in the mind of the writer of the paper to argue that because the plan is sufficient, simple and works admirably in one city that all companies, irrespective of size, should adopt this system as a method. For instance, the plan of organization, dividing the department into eighteen groups according to the nature of the work conducted might be altogether too many groups for a company half the size of the one described.

The plan, however, is so well thought out that its elasticity would be apparent to anyone and smaller companies could combine groups to suit the requirements of their own company and of course eliminate certain groups which were unnecessary in their opinion, such as the tabulating group. While the tabulating machines are convenient and necessary for large companies and might be a convenience for smaller companies the cost of operating would prohibit it where it was not almost a necessity.

On page 326 the paper states that in addition to a flat rate salary each meter reader is permitted to earn three-quarters of 1 cent for each meter read above a certain standard set for each route for the month. The question of meter readers has probably been a problem for most lighting companies. But it would seem that unless on the other side deductions were made for errors, the desire to earn the extra three-quarters of 1 cent on each meter would have a tendency to hurry the reader in order to earn some "easy money." And then again in most cities it is almost impossible to equalize the routes for each meter reader. I wish Mr. Patterson had told us a little more about how this bonus works out.

Will not the standards and the units be subject to continual change? Take it on the complaint group, the unit employed is the number of complaints handled. It might occur that one clerk working to cover a large number of complaints would not give the same courtesy and consideration to customers as another who was not working to cover the large number, but was working to give the best service possible. Then again we all know that one courteous clerk might be a half hour endeavoring to convince an unreasonable customer of the correctness of his bill or whatever the complaint was about, and these stubborn consumers might come to his lot all day while the next clerk would be getting along on simple complaints which would require but a word or two to explain the difficulty.

This same argument could be carried out in many of the groups and units employed. The answer to this argument, of course, is that the unit is the best that could be selected, and practically the only one, and the information obtained is of far more value than if no unit or attempt was made to gain any knowledge of what was being done.

On page 326 the paper mentions the installation of a Burroughs subtracting machine which automatically prints the dates and the index amounts of the readings, and makes and prints the subtraction, and is as easy to operate as the universally used adding machine. It also mentions the Todd Protectograph machines which print the gross, the discount and the net amounts on the bill and on the coupon in one operation by simply setting the machine for the number of cubic feet consumed.

Had the paper elaborated on the installation of these machines I think it would have been to the interest and advantage of many lighting companies. Few officials know that there is a machine on the market which will do with the ease and accuracy the work which these subtracting machines do. And again the Todd machine increases the ease with which the prices are placed on the bill and coupon and does the work in much less time than stamping or any other device the writer is acquainted with. Reduction of labor, ease, accuracy and neatness are accomplished with these two machines.

All of us who have had the opportunity to read or listen to Mr. Patterson's paper are indebted to him for his excellent treatment of the subject.

MR. H. W. SHERIFF (Detroit, Mich.): (Written discussion communicated.) I have read your paper on "Organizing for Cost Reduction in the Consumers' Bookkeeping Department."

If conditions are such in your city that meter readings can be made and bills rendered daily throughout the month, I can see no reason why your system should not give excellent results. I am strong on group organization and believe you have yours well arranged.

If your supervisors keep close check on all operations and employees are paid according to their efficiency and not according to what the supervisor thinks of their personality, you have the golden rule perfected.

MR. CLARE N. STANNARD (Denver, Colo.): (Written discussion communicated.) After carefully reading the paper I find that in the main the system described is very similar to the one in operation with this company for a number of years, which system in my estimation is an ideal one for a company similar to the Rochester, Denver or larger companies. I feel, however, that it is too elaborate and expensive for small companies.

If possible, I favor the idea of eliminating the night shifts and I am inclined to believe that the system can be made sufficiently elastic to obviate night work.

I am also in favor of consolidating the gas, electric and merchandise ledgers. I feel that where possible unnecessary detail work should be eliminated.

I congratulate you on the many splendid points so effectively mentioned and feel the paper will prove of great interest to the gas fraternity.

In sending you the above comments I regret that I am not able to make additional points, but the truth of the matter is the system is so similar to our own which has worked out so satisfactorily that I am not in a position to do otherwise than agree with you.

MR. EWALD HAASE (Milwaukee, Wis.): (Written discussion communicated.) The principle of organizing employees into groups governed by the nature of the work performed is fundamental, correct and leads to specialization of functions and efficiency in operation. The groups selected by Mr. Patterson are those into which the work of the consumers' accounting department naturally falls. Local circumstances and arrangement of office space are often factors that affect the formation of groups. Our experience leads us to prefer the combination of certain separate functions into one group rather than separate groups for each. For instance, in our case, the order writing function is performed in the application group of which it is an adjunct. This combination seems to make for greater directness of action. It may be that Mr. Patterson's order group is so intimately in contact with the application group as to be virtually one. We also combine meter reading and bill delivery functions in one group. There is another combination that seems to us very advisable and that is the collection group and the credit group. Having these two functions combined in one department brings that intimate information about accounts, gained from their collection, into immediate use in the granting of credits. Any material separation of these two activities is unthinkable to us.

Is there not some danger in establishing too many groups and having more or less unemployed time in the groups? It is obvious that a certain number of groups arranged to take care of the work of 100,000 consumers would be too many subdivisions for the work of 10,000 consumers and so it is possible to make as many groups for the work of 100,000 consumers as would take care of 400,000.

The introduction of machines for billing and posting or for practically all the operation of bookkeeping leads naturally to the functional grouping of work on the ledgers and makes it desirable to get away from placing under the charge of one person all of the operations on one ledger or group of ledgers. But even under the latter method of accounting, functional specialization can be carried on. While the work of registering the bills, taking off footings of sales, posting, taking off delinquent list, balancing and all work performed on the ledgers themselves is done by one man who is responsible for a group of accounts, there is considerable auxiliary help that can be given him which may be accomplished by cheaper help. The preparation of bills, extension, or machine billing if introduced, the listing of cash coupons, sorting coupons, etc., can all be specially performed by assistants. Under a system of meter reading by three or more districts the work of such a ledger keeper becomes very uniform throughout the month and a number of accounts is assigned to him, that will be a full task and take all of his time to perform. The splitting up of the responsibility for balances among a group of ledger men make the concern about getting balances disappear. Of course, some relief help is always at hand to pitch in at the weak point.

What the mechanical bookkeeping by different types of typewriting machines has in store for us as applied to consumers' bookkeeping is perhaps for the immediate future to say. Interesting experiments and trials on a large scale are now going on and progress is being watched with close attention.

MR. R. F. BONSALL (Baltimore): (Written discussion communicated.) This paper is exceptionally interesting, as the system spoken of has been in operation by the Consolidated Gas, Electric Light & Power Company of Baltimore for some time and has worked out very satisfactorily in taking care of some 160,000 customers and some 25,000 merchandise accounts.

We wish to point out briefly several apparent differences in methods between the Rochester company and ourselves, which we feel not only result in economy, but tend to give the customer quicker service:

BILLING GROUP.

We formerly experienced a great deal of difficulty in our billing group in handling those cases where a customer discontinues service at one address and immediately took service at another address, leaving a balance open at the former location. This resulted in a separate bill being rendered for this balance and it being handled as an entirely separate proposition, except that where possible we placed the new address on the bill for the use of the collection department.

For several years we have been taking the new application as "in continuation of" service at the old address, and upon this order being completed, the bookkeeping department immediately transfers the balance to the new account, although they immediately render a final bill against the customer at the old address. This means that the customer is given opportunity to take advantage of the discount, but makes the balance automatically go on the bill at his new address if the account is not paid by the time the other bill is rendered. We found that such a condition saved us considerable expense in our Collection Department, as well as made automatic the collection of accounts which might otherwise drag along if they were handled by what we term "discontinue" collectors instead of by the current collectors.

ORDER GROUP.

Mr. Patterson states that all orders for the turning on and shutting off service as well as for the setting and removing of meters are issued by this group. In Baltimore our applications for service are made out in duplicate; the original is filed as a permanent record, and the duplicate is used as the line order, except in those cases of "set-removes," or about 12 per cent. of the total, where we have to typewrite the order on account of the number of copies required by the operating department.

METER READING GROUP.

In Baltimore we have three different classes of meters; namely, weekly, semi-monthly and monthly, a different colored sheet being used to designate the class of account, although both gas and electric meters are handled on the same sheet. This method materially reduces the amount of detail work, as well as the weight and thickness of the handbook.

BILL DELIVERY GROUP.

While we do not recall ever having the bill distributors stop to give the customer opportunity to pay the bill, it has been discussed several times, with the result that we have always been of the unanimous opinion that it would not pay.

We would like to hear some of the results accomplished by other companies.

COLLECTION GROUP.

In addition to the duties of the collection department as stated by Mr. Patterson, we have also a corps of men who make both the disconnections and connections for non-payment, which means that we secure much quicker results in both cases, than when we had to send the orders to another department for execution.

We have had excellent results from having certain groups of men report at other than the regular office hours. In addition to those mentioned in this paper, we have a man report in the collection department at midnight, whose duty it is to follow up the ledgers after being posted, and pull out all delinquent payments of that day, thereby permitting the collection department, at the opening of business the following morning, to have only collectible accounts.

BOOKKEEPING APPLICABLE TO APPLIANCE OR MERCHANDISE ACCOUNTS.

Mr. Patterson states that it is deemed inadvisable to merge the merchandise in the same ledger with the gas and electric accounts. Our experience in Baltimore has been decidedly the reverse. We find that the public appreciates receiving only one bill, thereby informing them of their total indebtedness to the company for the month. They are thereby enabled to draw one check, which as far as they are concerned covers the transaction, and as far as the company is concerned, permits the posting in the ledger to be done on the one folio.

Our method of handling this merchandise accounting is simply, that we receive a copy of the merchandise ticket when the work is completed, and after making the necessary tabulations to the different accounts involved, the tickets are sent to the typist and entered on the bill, a different form being used in the case of cash and lease orders. These bills are kept in a binder during the month and any succeeding purchases made by the customer between meter reading dates is entered on this same bill. The typewriter used has an adding machine key which renders the total of the day's billing available to check against the total amount of the tickets sent by the merchandise department. Two days before the meter reading day the bills of that meter reading section are removed from the binder and totaled, and sent to the billing department in ledger and folio order. Only the total of the bill is entered on the ledger in the merchandise column and the bill is left in the ledger at its corresponding folio, so that the bill clerk in billing the account simply enters the total amount of the merchandise bill on the service bill and attaches a copy of the merchandise bill thereto; thus, we use only one posting a month for the ledgers for the total merchandise purchases of any one customer, and at the same time only make one posting for the amount paid. Of course, when a customer buys under both the cash and the lease plan, there are two separate merchandise bills attached to the one service bill, for the reason that our bills show how many months' payments are to be made and how much per month, or in case of 30 days, it is so stated.

A carbon copy of these merchandise bills remains in the binder, available for use in making duplicate bills or in answering customers' inquiries. The same routine is gone through with in handling credits, except the entries are reverse.

Another point in the Baltimore system which we feel is a good one, is that in having the balancing done by separate clerks who become specialists in that line. These men not being directly interested in the preparation of the work as they make no entries, produce far better results and are possibly more willing to list all errors found, than is the case where one man makes the entries and balances the book.

If any one is interested in either our merchandising or balancing system, we would be glad to send them a set of the forms used, as well as an explanation of their use.

MR. WALTON FORSTALL (Written discussion communicated): Not being an office man, I am not competent to discuss the details of this paper, but I am heartily in sympathy with the idea of obtaining unit costs for the different operations. In the Philadelphia distribution department, we have been using unit costs for all of our operations since 1900, and we believe that such a practice is the foundation stone for economical and efficient service. It is interesting to note how the idea can be applied to the office work of a company.

I would like particularly to call to the attention of the Institute members Mr. Patterson's statement on page 329, of the practice of the Rochester management of basing salary increases on results shown by the monthly reports. The larger a company is, the more essential does it become that employees be paid for results obtained, for in no other way can the average of performance be made so high. The motto of those in authority should be "Pay the man, and not the place." In other words, do not base salaries on what the job ought to be worth, but actually on what results the present incumbent is obtaining.

MR. H. B. REINACH (New York): Do you use the loose-leaf system?

MR. PATTERSON: Yes.

MR. P. L. KING: How many do you put on a leaf?

MR. PATTERSON: We have just adopted a new form. We have not circumscribed it with any dates whatever. I think it will last 3½ or 4 years.

MR. KING: Do they all run out at the same time or different times?

MR. PATTERSON: Not all together. That is where our trouble came in this year.

THE CHAIRMAN: It will probably be in order for us to adjourn the meeting to to-morrow morning at 10 o'clock. We have two very important papers and some proceedings that will interest all, and I hope there will be a large attendance. You have been very patient this afternoon. I hope you will feel rewarded for your patience. I thank you very much for your kind attention.

An adjournment was here taken to 10 o'clock A. M., Wednesday, October 18, 1916.

MANUFACTURING SECTION (Continued).

Third Session, Wednesday 9:30 A. M., October 18.

MR. H. C. ABELL, *Vice-President,* presiding.
MR. J. S. JACKSON, *Secretary.*

The Chairman called the meeting to order at 9.30 A. M.

THE CHAIRMAN: The first paper we have this morning is "New Oil Gas Plant—Portland, Oregon," by Mr. E. L. Hall. Is there any one present representing Mr. Hall?

I will ask Mr. Flower to abstract this paper hurriedly. I think he has gone over part of it.

NEW OIL GAS PLANT—PORTLAND, OREGON.

INTRODUCTION.

Portland, Oregon, is located at the junction of the Willamette River and the far-famed Columbia, and by reason of this fortunate geographical position, has become one of the largest cities on the Pacific Coast, the leading lumber producing city in the world, the second largest grain shipping center in the United States, and is also noteworthy as a financial center.

The territory served is shown in Fig. 1.

Due to the phenomenal growth since the Lewis and Clark Exposition in 1905, the old site of the gas works at Front and Everett Streets, consisting of a few city blocks on the water front, became inadequate to take care of the continuous additions to plant and machinery, while the business center drawing its cordon tighter around the manufacturing activities, brought about increased complaints against the smoke and odor in connection with manufacturing operations. Growing inefficiency and inadequacy of the old machinery, most of which had been in use for many years, called for a reconstruction of the plant. It was, therefore, decided in 1910 that the time had come to move the manufacturing plant to the outskirts of the city.

PRELIMINARY ENGINEERING.

The site selected, admirably located, consists of about 40

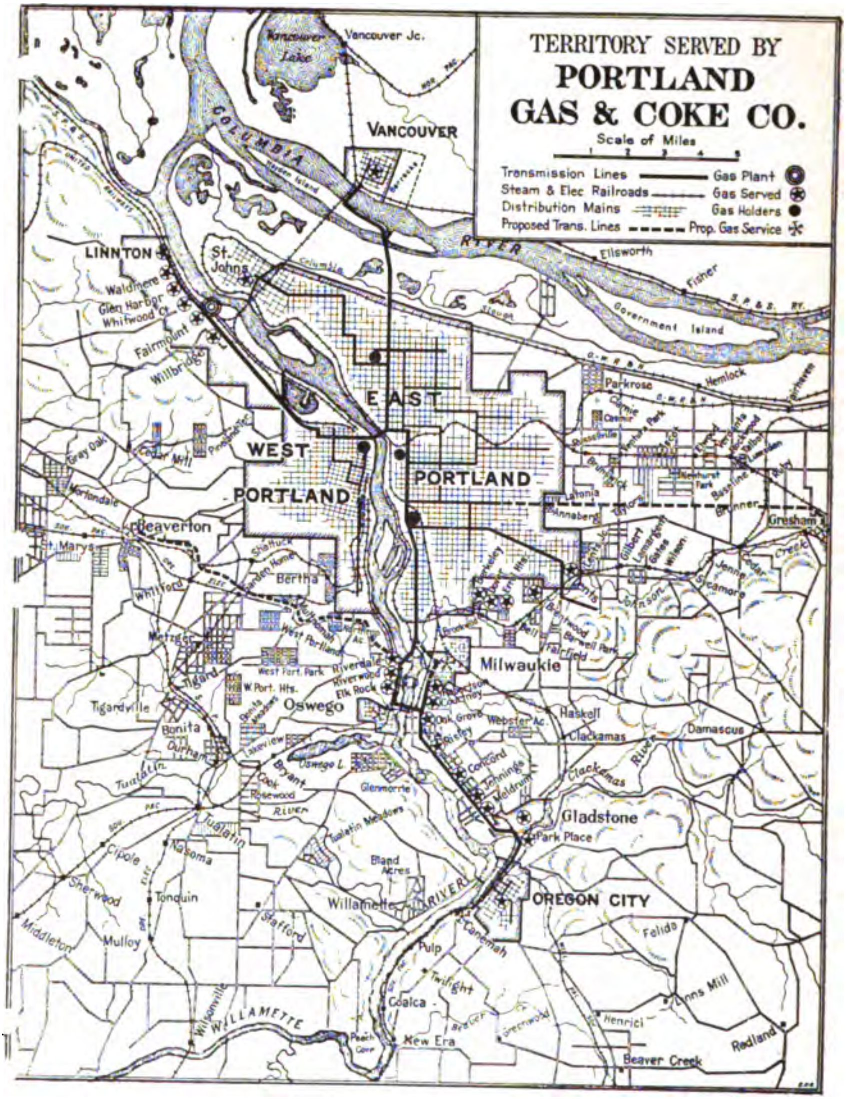

TERRITORY SERVED BY
PORTLAND
GAS & COKE CO.
Scale of Miles
1 2 3 4 5
Transmission Lines
Steam & Elec Railroads
Distribution Mains
Proposed Trans. Lines
Gas Plant
Gas Served
Gas Holders
Prop. Gas Service
Vancouver Lake
Vancouver Jc.
VANCOUVER
COLUMBIA
RIVER
Hayden Island
LINNTON
Waldmere
Glen Harbor
Whitwood Ct.
Fairmount
Willbridge
St. Johns
Ellsworth
Fisher
Government Island
Parkrose
Hemlock
Fairhaven
EAST
PORTLAND
WEST
PORTLAND
Gray Oak
Cedar Mill
Mortondale
Beaverton
St. Marys
Whitford
Bertha
Metzger
Tigard
Tigardville
Bonita
Durham
Tualatin
West Port. Park
W. Port. Hts.
Oswego
Riverdale
Riverwood
Elk Rock
Milwaukie
Lakeview
Oswego L.
Cook
Rosewood
Glenmorrie
Tualatin Meadows
Bland Acres
Oak Grove
Risley
Concord
Jennings
Meldrum
Webster Ac.
Haskell
Clackamas
Damascus
Clackamas River
Gladstone
Park Place
OREGON CITY
Willamette
RIVER
Stafford
Canemah
Pulp
Twilight
Coalca
New Era
Peach Cove
WILLAMETTE
Wilsonville
Cipole
Nasoma
Sherwood
Tonquin
Middleton
Mulloy
Annaberg
Latonia
Gresham
Felida
Linns Mill
Henrici
Redland
Beaver Creek
Greenwood

FIG. 1.

acres of low-lying meadows, 6 miles below the city. Being located on the main line of the Northern Pacific Railroad, it has excellent railroad facilities.

The property presented, however, certain drawbacks from a construction standpoint; namely, the low elevation above the Willamette River and the character of the subsoil on certain portions of the tract.

Before anything was done in preparing the plans and specifications for the new plant, it was necessary to thoroughly examine and test the soil conditions in order to make the layout conform, thereby avoiding undue expenditures for foundations and insuring continuous operation during abnormal periods of high water.

Accurate surveys were made of the property and contour lines established, and that portion of the tract presenting the largest area of high ground was selected for the approximate location of the plant. Meanwhile, several tentative lay-outs had been drawn up and these were staked out on the ground, and borings were made from October 15, 1911, till October 30, 1911, to depths ranging from 30 to 100 feet.

As a result of the information contained in these borings, a layout, shown in Fig. 2, was located, necessitating a few additional borings, which were begun December 31, 1911, and completed January 12, 1912.

There was not sufficient high ground available to locate all the buildings above the highest known flood state of the Willamette River, which was approximately 34 feet above the government datum, and it was therefore necessary to fill in the property to this elevation. This operation was rapidly and economically made possible by the large government dredges operating in the Willamette and Columbia Rivers.

For this purpose it was necessary to drive a double bulkhead around the area to be filled. This construction work was advantageously combined with dock and wharf, the latter to serve for the bringing of construction supplies and later to afford anchorage for fuel oil steamers from California.

PROGRESS OF CONSTRUCTION WORK.

Water pile driver arrived on the job April 1, 1912, and drove eight temporary piles along the water front to anchor log rafts and barges. This date represents the beginning of construction work. Simultaneously work was begun with the land pile driver and the whole job including the bulkhead, dock and wharf, was completed on June 1, 1912.

On account of the large quantity of drift at certain seasons in the Willamette River, it was necessary to build a sheer boom to protect the dock and wharf, consisting of 13 three-pile dolphins, connected with boomsticks.

All the fill, consisting of 180,381 cubic yards, was made with the Port of Portland 30-inch suction dredge Columbia. Pumping started on June 3, 1912, and was completed on June 24, 1912. Illustrations of the work are shown herewith.

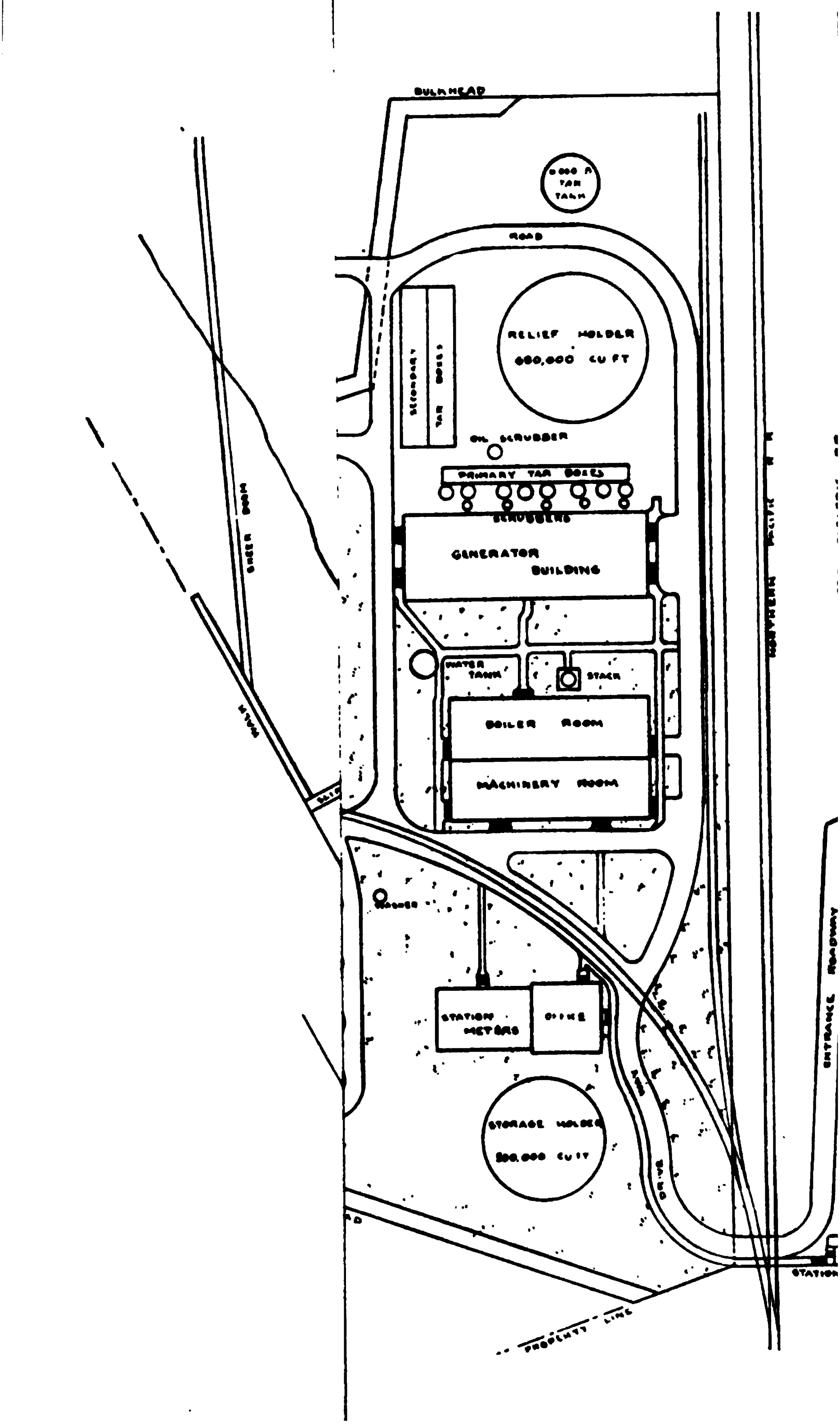
After the completion of the fill, it was necessary to remove certain high ground, which excess earth was deposited against the bulkhead, in order to form a permanent protection for the sand fill after the decay of the bulkhead. There were removed in this manner approximately 7,900 cubic yards, at a cost of approximately 21 cents. Part of this work was done by steam shovel and part with teams.

Very careful elevations were taken immediately after completion of the sand fill and for a period of 3 months, during which period an average settlement was shown of 10-5/16 inches.

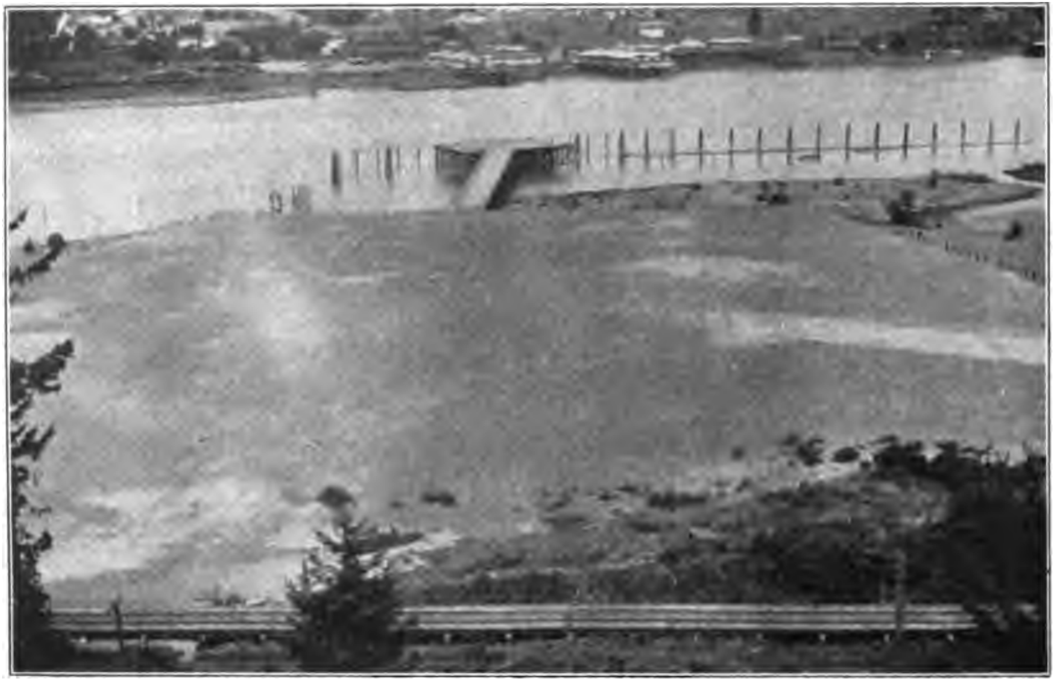
The property was now ready for the erection of the buildings.

The Northern Pacific Railway located spur tracks on June 28, and on July 3, stakes for the buildings and holders were set, on which actual construction work was started July 17, 1912.

Additional careful soil tests were made on the bearing power of this sand fill, and since it was not practical to carry the footings to bed-rock, or to the original formation, it was decided to use spread footings and mats.

BULKHEAD
TAR TANK
ROAD
RELIEF HOLDER
680,000 CU FT
SECONDARY
TAR BOXES
OIL SCRUBBER
PRIMARY TAR BOXES
SCRUBBERS
GENERATOR
BUILDING
WATER
TANK
STACK
BOILER ROOM
MACHINERY ROOM
WASHER
STATION
METERS
OFFICE
STORAGE HOLDER
300,000 CU FT
DRIVE
PROPERTY LINE
NORTHERN PACIFIC R R
ENTRANCE ROADWAY
STATION
SEWER DRAIN
MAIN

BULKHEAD BEFORE BEING FILLED.



BULKHEAD AFTER BEING FILLED.

Buildings and holders, and the majority of the gas apparatus were erected simultaneously, and the heavy construction work was completed in June, 1913.

While the foregoing was in the progress of erection, all other installation work, consisting chiefly of piping machinery, sewers, electric conduits, wiring, etc., was being done and tested out, and by the 27th of October, 1913, the plant was practically completed and was placed in operation.

Considerable additional work, however, was done after the above date and it was not until the middle of January, 1914, that the concrete roadways and all other small details were completed.

DESCRIPTION OF PLANT.

Buildings and Grounds.

In the designing of this plant, two points were kept uppermost in mind: Firstly, to attain the highest possible efficiency in operation, profiting by our experience of oil gas manufacture at the old plant; and secondly, to eliminate what heretofore had been the principal source of complaints against the operation of gas works, namely, dirt, soot, smoke, cinders, etc., together with the untidy appearance of things and the gloomy, grimy and ugly buildings.

The second feature was therefore the uppermost consideration in designing the buildings and laying out the grounds. Several types of architecture were considered. The type finally selected conveys the impression of solidity, permanence and dignity, impressive both to the investor, by creating a feeling of solid strength and security, and to the citizen in the community by the pleasing and harmonious conformation to the ideals of municipal growth. The setting for the buildings is picturesque, namely, in the foreground, the wooded heights of spruce, hemlock and fir, and in the background, the glistening waters of the Willamette River. Concrete drives and walks unite the buildings and storage sheds, while the vacant spaces are covered with green lawns and attractive shrubbery.

BUILDINGS AND GROUNDS.

The buildings are of reinforced concrete, containing 1-inch sized crushed rock, which has been bush-hammered on the exterior to produce the effect of granite, this process, besides being comparatively as cheap as plastering, is more permanent and produces a greatly superior effect. The roofs are of terra-cotta colored shingles, layed on the French diagonal method. Streets and driveways are provided with curbs, sidewalks, sewer connections, etc., and are illuminated with gas arc lamp posts.

The office building is a two-story structure 50 by 50 feet in plan and houses, on the rear, the works station meter. On the lower floors are the superintendent's and clerks' offices, drafting room and lunch room, while on the second is the works laboratory. The machinery building, next in line, is 90 by 150 feet in plan, with a basement of 45 by 120 feet, and houses all the power plant and boilers, gas exhausters and gas compressors. A portion of this building reserved for future extensions, is now occupied by a men's dressing room and lavatory.

The generator building is 60 by 182 feet in plan and is designed for two rows of five 20-foot oil gas generators, space being left at the end of the building for the motor-driven air blowers. The building is carried on its own foundation, entirely separate from the generators, which are carried on concrete piers 12 feet high, on separate foundations. The basement thus formed serves for brick storage and, at the far end, for the oil heaters and strainers.

Other buildings are the oxide and shavings storage building, which is 100 by 100 feet, of heavy mill construction and is covered by hyrib metal lath, and located approximately to the purifiers. The briquette storage building is 200 by 206 feet and is built of similar material as the oxide shed. The briquetting plant building is 93 by 96 feet and is built of the same material as the foregoing.

Located near the dock and river front is a brick and concrete water and oil pump house, which is 15 by 45 feet in plan and comprises three floors, the upper of which is prin-

LABORATORY.

cipally a gangway and a location for motor controls and meters, while the second floor houses the oil pumps.

The lower floor is usually below the river level and here are located the water pumps, which in this manner, operate under little or no suction. This building is flanked on one side by a water intake, 6 feet in width by 270 feet long, consisting of creosoted sheet piling, driven interlocking and with heavy timber bracing, equipped with a rack or screen at the river end, and a gate and supplementary screens. Immediately adjoining the pump intakes is a dock 70 by 106 feet, with walks extending at either end to five mooring dolphins, communicating with the shore by a trestle about 250 feet long.

The dock and water intake are protected by sheer booms, connected together with boom sticks, arranged to raise and lower with the water level of the river.

OIL GAS APPARATUS.

Theory.

The production of gas from crude petroleum is essentially a process of high temperature cracking. There has been much apparatus designed for this purpose but the variations can all be reduced with but few exceptions to construction details of size, form and dimensions, rather than to essential difference in the process.

We may repeat therefore that the oil gas production as a process, must be treated purely as an oil cracking process, subject to the same factors of temperature, pressure and contact with highly heated surfaces.

The gas maker as a merchant must consider how to cheapen his product by all the manufacturing economies, among which the most important is the utilization of by-products. In other words, he strives to produce the greatest number of B. t. u.'s per dollar. This is true of all the gas making methods.

This problem, from the standpoint of oil production has been attacked in two different ways:

1. By elimination of all by-products, *i. e.*, by conversion of all the raw material into gas.
2. By the production simultaneously with the gas of the largest amount of merchantable by-products on the theory that weight for weight the latter are worth more than the raw material.

The first method has been developed under the auspices of Mr. E. C. Jones of San Francisco, and the results described in a paper by his son, Mr. L. B. Jones.

The process is of great theoretical interest, but unfortunately has not as yet evoluted to its maximum possibilities, *i. e.*, the complete elimination of lampblack as a by-product. The further development of this process to its logical end is hindered by the high standards of quality of gas prevalent in California, *i. e.*, a 600 B. t. u. or higher.

The second method is of more universal application and is exemplified in most of the coast cities in so far as the by-products are marketed, by Los Angeles, San Diego, Oakland, California, and Portland, Oregon. Nearly all the other oil gas plants produce lampblack, but have not sufficient volume to briquette.

Both methods have their merits and their advocates and in the final outcome it will no doubt be found that local conditions will determine the process to be adopted.

Where there is a good fuel market and oil is cheap, it will unquestionably pay to produce by-products.

Investigations made by the Portland Gas & Coke Company, at the instance of the Bureau of Standards, showed that for our local conditions, a 525 B. t. u. gas would, if by-products were fully manufactured and sold, deliver to the consumer the most B. t. u. for a dollar. The present standard of 570 B. t. u. in force in the State of Oregon therefore represents, from a gas making standpoint, an incomplete and wasteful process.

If, however, this standard were maintained it is interesting to consider what should be the composition of a gas produced from crude oil in order that the minimum percentage of the original carbon should be utilized in producing the necessary B. t. u. per cubic foot. Without going into the calculation, an analysis is given below of which a 560 B. t. u. gas containing the minimum carbon, and which would, therefore, produce the greatest amount of carbon residue per thousand cubic feet of gas.

This analysis represents a methane-hydrogen gas and is predicated on the assumption that the carbon dioxide and nitrogen will remain the same in volume, which is not necessarily the case.

The selection of oil gas apparatus for the new plant was further investigated relative to costs per 1,000 cubic feet of daily gas capacity and it was decided that the installation costs for a single shell type per unit of gas making surface were considerably lower—as was to be expected.

560 B. T. U. GAS WITH MINIMUM CARBON.

CO_2	1.2
C_6H_6	None
C_2H_4	None
O_2	0.7
CO	7.2
CH_4	37.0
H_2	51.5
N_2	2.4
	100.0

Before proceeding with a description of the gas apparatus, it may be interesting to some gas engineers to describe the oil gas process, by which the greater portion of manufactured gas on the Pacific Coast is procured.

Oil gas, while manufactured in apparatus and by a process somewhat similar to the manufacture of water gas, produces a gas strikingly characteristic to coal gas, as may be seen by the following analysis of gas as produced by the Portland Gas & Coke Company, for typical 570 B. t. u. oil gas:

Carbon dioxide	1.4
Benzene	1.4
Ethylene	3.1
Oxygen	0.2
Carbon monoxide	6.0
Hydrogen	52.45
Methane	28.3
Nitrogen	7.18
Gross B. t. u. calculated	578.5
Specific gravity	0.4135

A striking and essential difference in this process is the fact that the only important by-product is a large quantity of very pure carbon, comprising frequently as high as 50 per cent. of the weight of the original oil.

The principal problems arising in the manufacture of oil gas present themselves in connection with this residual.

Firstly; by reason of the mechanical difficulties introduced of cleansing of the gas and the recovering of this valuable substance.

Secondly; by the fact that there are produced with this carbon, varying amounts, of a very pitchy tar, with but very little commercial value, which, if allowed to condense, at the same time the lampblack is removed, produces a spongy substance most difficult to handle and which, in a short time, will completely block up the apparatus and passageways.

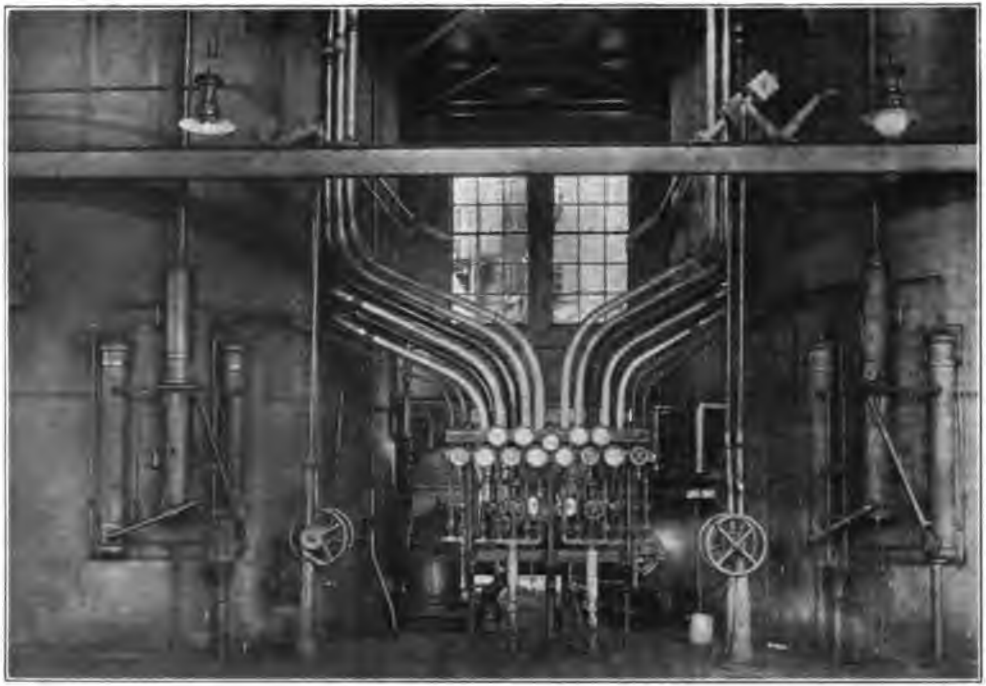
As is usual in manufacturing problems of this description, the means used by the pioneers of the art to handle this substance were both cumbersome and complicated. The writer has frequently seen plants in California and Oregon, where from one to five hours were consumed daily in ridding the washers and scrubbers of this accumulation. As the art progressed and the theory of oil gas condensing and washing was better understood, the apparatus was so designed as to mechanically and automatically separate the lampblack from the tar at appropriate stages in the process. The manufacture is also troubled with the usual bug bears of naphthalene, cyanogen and sulphur, without the compensation of ammonia recovery, which substance is present in only the faintest traces.

Gas Generators.

The five gas machines have each a capacity of generating 2,000,000 cubic feet of gas per day. Each consists of a cylindrical shell 20 feet in diameter and 30 feet 6 inches in height, with conical-shaped top 4 feet high, all of which is constructed of 3/8- and 1/2-inch steel plating. On the sides near the bottom are two 36-inch diameter drums for the blast connections and in the rear is a 36-inch diameter off-take nozzle. Just above each of the two inlets are two 10-inch diameter nozzles for the gas-making burners. Eight cast-iron manholes are distributed about the shell for access below the arches and to the checker brick, and on the top is a 34-inch diameter stack valve which operates by steam hydraulic cylinder. Steam and oil piping connects to all of the burners, which are controlled from an operating panel located between each pair of generators. Here also valves for operating the stack valve, gauges for all steam and oil connections and oil meters, and also hand operating stands for the 24-inch diameter blast valves.

An all steel platform is provided around each generator for access to the gas making burners and an additional platform at the top for cleaning the stack valve. Steel stairways lead to these platforms, all of which are equipped with pipe handrails and wire guards.

The lining of the generators is 16½ inches in thickness, consisting of 13½ inches of firebrick and 3 inches of asbestos. At the bottom, thirteen arches, 9 inches in width and having an air space of 6 inches between, are installed for supporting the checker brick. These arches span half the width of the machine and rest on the center on a wall, which extends entirely across the shell and the latter is provided with two small arches for permitting the air blast to get from one side of the generator to the other. The crown is composed entirely of wedge-shaped blocks, which are supported on large skew backs, placed on the top of the lining wall. Special shaped blocks are provided for the air inlet and off-take connections and also for the burners and manholes. The operation of these units has been



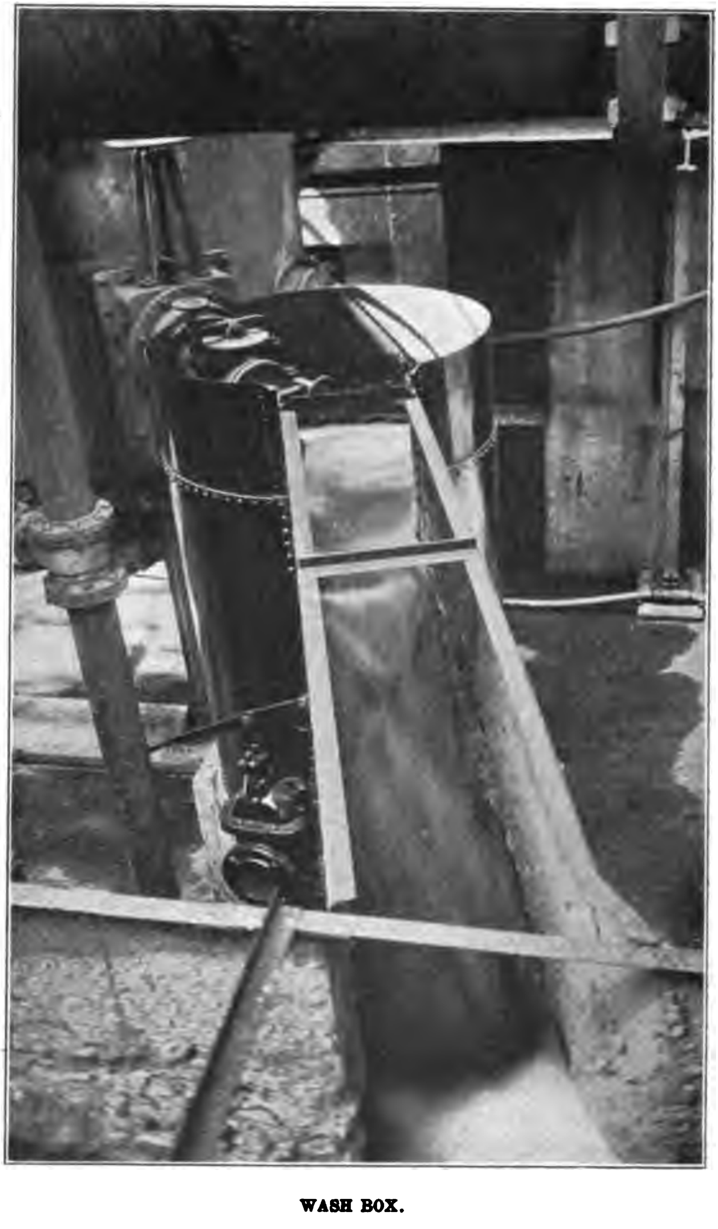
GENERATOR CONTROLLING VALVES AND GAUGES.

so standardized by means of the improved construction that the life of the checker work is at least two years.

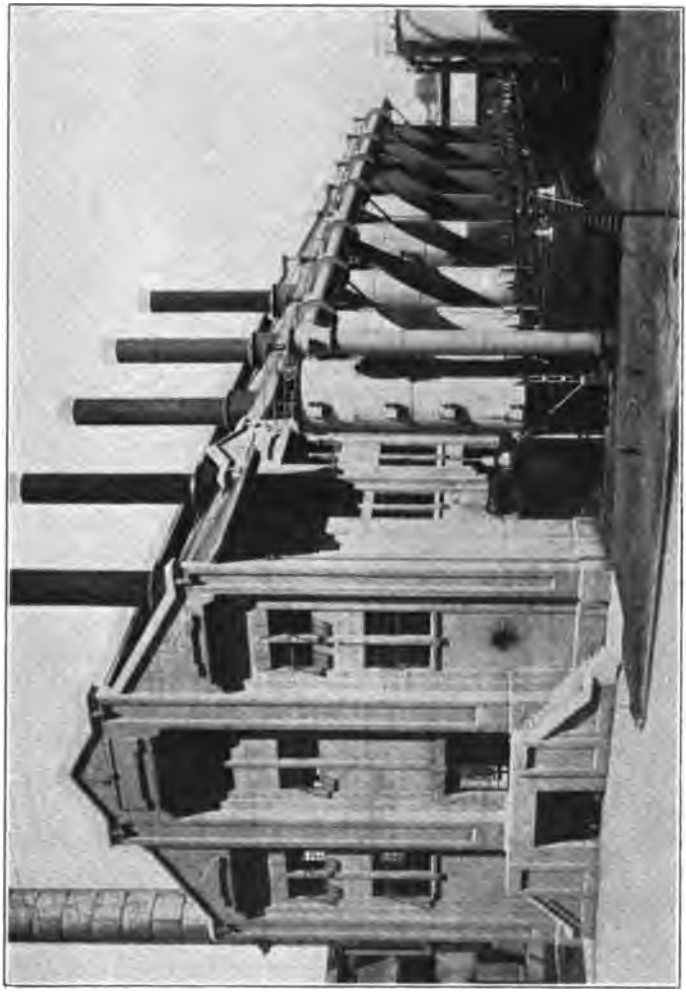
Wash Boxes.

In the rear of each generator and just outside of the building wall are five wash boxes, each of which is connected to a generator by a 36-inch diameter pipe, which is firebrick lined and which reduces to a 24-inch diameter cast iron ell with clean out doors at the wash box for connecting the dip pipe. The wash boxes are 8 feet in diameter and 7 feet in height and are constructed of ¼- and $^5/_{16}$-inch steel plating. They are provided with hopper bottoms and are supported above the yard level on structural steel columns.

The dip pipe which is 24 inches in diameter, enters through the top and extends sufficiently into the wash box to insure a minimum water seal of 10 inches. The lower part of this pipe is equipped with a flange or hood grooved for rotating the water and a suspended disc is provided for closing off the pipe. The gas outlet, which is also at the top, is of the same size and has cast-iron ell and pipe for connecting to the primary scrubbers. Three connections on the top are made for admitting the water. These are arranged with a special shaped casting for spraying the water into the shell. The overflow outlet is of cast iron and is riveted to the side of the shell. It is arranged with movable gate to allow raising the water seal and is provided with outlet pipe 10 inches in diameter. This pipe is sealed in a steel drain tank 4 feet in diameter and 5 feet in height, which is connected by means of a steel flume to an underground pipe line extending to the filters at the briquetting plant. Other connections on the seal tanks include two cast-iron manholes in the sides and 8-inch valve in the center of the bottom for cleaning purposes. As a result of the improved construction the cleaning of wash boxes, scrubbers and seal pots has been entirely eliminated and the separation of lampblack and tar accomplished in two distinct stages, *i. e.*, lampblack is entirely removed in the wash boxes and the tar entirely in the scrubbers, thus allowing each constituent to be easily and automatically eliminated.



WASH BOX.



GENERATOR BUILDING.

Primary Tar Scrubbers.

One primary tar scrubber is provided for each generator. These are each 10 feet in diameter and 28 feet in height and are constructed of $^5/_{16}$- and ¼-inch steel plating. They have conical bottoms and are supported on the structural steel columns similar to those of the wash boxes. The inlet and two outlet connections are 24 inches in diameter and the latter are so arranged as to permit the passing of the gas either to the secondary scrubbers or directly to the 36-inch diameter header leading to the relief holder. Water is admitted at the top by means of an "H" shaped spray and the scrubbers are drained at the bottom by a 12-inch diameter pipe, connected to and sealed in the primary tar boxes, without the use of the usual seal pots.

The interior of the scrubbers is equipped with five conical rings, which are riveted to the shell and five small cones, both of which catch the water and form a spray through which the gas passes.

Platforms are provided along the tops of the scrubbers and at the floor level, along the building wall, for access to the valves and for cleaning purposes. Steel stairways lead to all of these platforms and where necessary, hand rails are installed. For the large valves, extension stems are arranged for operating from the ground. Each scrubber is equipped with six cast-iron manholes for access to the cones and water sprays.

Final Cooling Scrubbers.

Three final cooling scrubbers have been installed, one of which is arranged to handle the gas from each pair of generators. The shells and supports are identical to those of the primary scrubbers and also the water inlet and drain connections to the tar boxes. The inlets for each, of which there are two, are 24 inches in diameter and connect to the outlet of the primary scrubbers. The gas outlet is of the same size and connects to the 36-inch diameter header previously described.

There are cones in these scrubbers; the interior is filled with wooden trays, which are supported on steel angle irons riveted to the shells. The platforms, stairways, etc., are the same as those of the primary scrubbers.

The gas passes from final scrubbers to relief holder whence it is drawn through the following apparatus.

OIL SCRUBBER.

In common with the history of all gas plants, naphthalene troubles had occasionally made themselves felt, with this company, particularly after the introduction of oil gas and high temperature operation. Profiting, however, by the European experience in anthracene oil washing, which was readily understood to be merely a process of physical solution, experiments were instituted by the writer in 1907 and 1908, as a result of which an 8 by 30-foot oil scrubber was installed at the old plant. About the same time a similar development occurred in the plant of the Los Angeles Gas & Electric Company and the technic of the process was worked out by Mr. Wade, chemist, and Mr. D. J. Young, superintendent.

As a result of this experience, crude oil washers 10 feet in diameter by 30 feet high, with automatic oil pumps and receiving tanks, were installed at the new works. Due to oil washing, naphthalene complaints are practically unknown. The four or five calls which are received per month from this source are derived mainly from oil deposits. The process has been well described in an article before the Pacific Coast Gas Association by Mr. Wade, in a paper entitled: "The Naphthalene Problem in Oil Gas Manufacture and Distribution."

The oil scrubber is 10 feet in diameter and 30 feet in height and is constructed of ¼- and $^5/_{16}$-inch steel plating. The gas inlet and outlet connections are 24 inches in diameter and the oil inlet, which at the top is 3 inches and the overflow at the bottom 6 inches in diameter. Oil is obtained from the main oil supply from the oil pumps in the pump house and the piping is so arranged as to permit using either cold oil or hot oil heaters for the generators. The 6-inch drain connections overflow into a steel tank 10 feet in diameter and 10 feet in height, which is buried under the ground and which is prevented from overflowing by a 6 by 4 by 6-inch Blake-Knowles duplex steam-driven pump, operated automatically by a float in the tank. This pump returns the oil through a 6-inch pipe line to the oil storage tank.

The oil scrubber is provided with a vertical steel ladder, extending from the ground to the top, where a hand rail is placed. Three cast-iron manholes on the sides give access to the interior, which is filled with wooden trays, supported by steel angle irons riveted to the shell.

The effect of the crude oil washing is to dissolve out the naphthalene present in the gas, which is, however, not lost, since the oil is eventually used for gas making when the naphthalene is made into gas.

About 5 gallons of crude oil is made to circulate through the oil scrubber per 1,000 cubic feet of gas made.

PURIFICATION.

The gas, after being subjected to the oil washing, is drawn through the elsewhere described exhausters and passes through a Gas Machinery Company Multiple Gas Washer for final cleansing before purification. The crude oil from which the gas is made contains normally from ¾ to 1¼ per cent. sulphur, which quantity is responsible for about 180 grams of hydrogen sulphide for every 1 per cent. of sulphur in the crude oil. This amount is accompanied by about 15 to 20 grains of carbon bisulphide and other sulphur compounds.

Gas purification is entirely by means of the well known Lamings mixture with selected planning chips, as a coating medium. Purification expense with this material has been materially reduced during the last few years by studies on the preparation of same without losing a great portion of the valuable copperas in the interior of the chips. In other words, means have been found to keep the valuable artificial iron oxide almost entirely in an available state on the surface of the chip.

There is used for the purpose of manufacturing this substance, an apparatus somewhat on the principle of a concrete mixer set up on a high platform and served by a small elevator.

Purifying System.

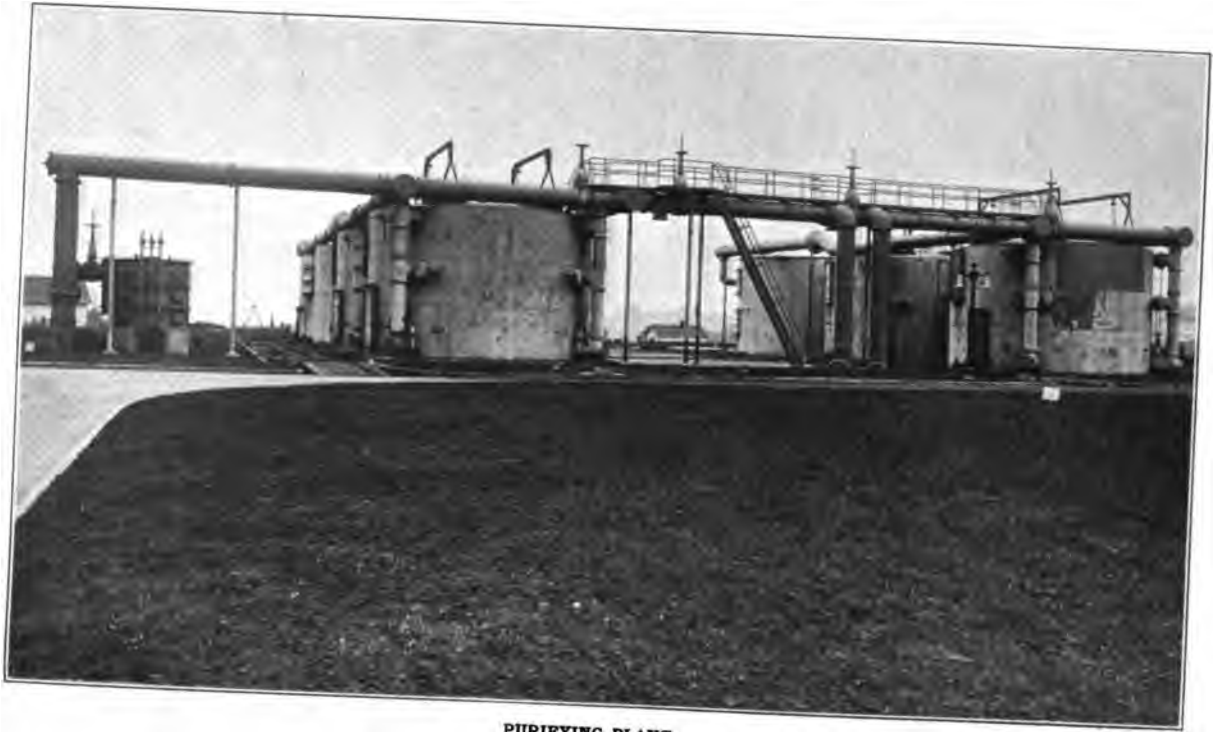
Primary Purifiers.—The primary purifiers, of which there are four, are 32 feet in diameter and 20 feet in height. Two of these were purchased from the Gas Machinery Company at the time the plant was constructed and the other two were moved from the old works on a barge. All are constructed of $^{3}/_{16}$- and ¼-inch steel plating and have spherical-shaped tops, and are designed for either simplex or duplex operation. The three inlet and three outlet connections are 20 inches in diameter and are arranged one above the other with valves so that the gas may be passed through any section or all of the purifiers, as desired.

Steel "I" beams and columns on the inside are installed for supporting four sets of trays, on which the oxide is placed. The trays are of wood and are built in sections, so as to facilitate handling and dumping.

On the top of each purifier two asbestos sealed doors, 6 feet in diameter and constructed of steel plating and angle irons are placed for installing the oxide and are provided with clamps for fastening and with chain blocks and overhead trolley for convenience in handling. On the sides for removing the oxide, are two doors 3 feet, 6 inches by 8 feet, 4 inches high, which are also of steel and are arranged with hinges, clamps and bolts for fastening. A 12-inch diameter blow-off valve is placed on the top of each purifier and on the side a 10-inch connection for air inlet. In the bottom is a 3-inch diameter drain connection, which is equipped with valve, funnel and strainer and piping connection to washer drain tank.

Between each purifier, at the top, a small platform is provided and a steel stairway extends to the ground. Along these and also around the top of the purifier steel pipe hand rails are placed. Most of the large gas valves are equipped with extension stems for operating from the ground and on the sides of the purifiers, where necessary, thermometer wells and test cocks are placed.

Secondary Purifiers.—Two of the secondary purifiers were purchased from the Gas Machinery Company and are identical



PURIFYING PLANT.

to the primary purifiers. One other secondary purifier, which was moved down from the old plant is 2 feet greater in height, but otherwise practically the same, except in the general construction where much lighter material was used.

In addition to having all of the connections, etc., as described, for the primary purifiers, the secondaries are equipped with steam heating coils located in the bottom. These consist of 2-inch piping spaced about 6 inches on centers and extending entirely across the interior of the shell, and arranged with steam inlet and outlet connections, on the outside.

Air Blower for Purifiers.—For reviving the oxide in the purifiers, a No. 9 Sturtevant steel pressure blower has been installed in one corner of the oxide and shavings storage building. It is direct connected to a 20-horse-power Form K. Type I-8—900 revolutions per mniute induction motor, and has piping connections 16, 14 and 10 inches in diameter, extending to each of the purifiers.

ORGANIC SULPHUR REMOVAL.

It has just been mentioned that the organic sulphur present in the oil gas is about 15 grains per 100 cubic feet. This amount, while noticeable to consumers, has not heretofore been considered poor practice by the fraternity. Such is not the case, however, when the sulphur amounts up in the raw material to 2 or 3 per cent. or even as high as 4 per cent., since the organic sulphur amounts up in proportion and reaches a quantity as high as 60 grains per 100 cubic feet, at which point the gas is unfit for domestic use and many other purposes. This condition was experienced by the Portland Gas & Coke Company soon after changing over to the oil gas and would have barred out that process entirely, if means had not been discovered for eliminating this impurity. The process has been described before the Pacific Gas Association at the 1908 meeting by the writer and again before the American Gas Institute in the year 1910 by Hilmar Papst, general manager, of this company. It is gratifying to the writer to note that the process has since been, with the necessary modifications to

OXIDE SHED.

overcome patent rights, been successfully introduced by the South Metropolitan Gas Company of London, England.

The process consists essentially of purifying the raw gas from hydrogen sulphide and raising same to a temperature from 900 to 1,200° F., thus breaking down the organic sulphur to hydrogen sulphide, cooling the gas and then again passing the same through a set of purifiers, to eliminating the hydrogen sulphide produced.

The reaction is a simple mass action in which the original sulphur distributes itself between hydrogen and carbon combinations reaching an equilibrium at a certain proportion of hydrogen sulphide and carbon bisulphide.

This same equilibrium is destroyed by the removal of the hydrogen sulphide in the primary purifiers so that when the temperature of reaction is again restored and mass action equilibrium is again established, the organic sulphur is re-distributed between hydrogen and carbon radicals in the same proportion as in the primary reaction, thus producing a new amount of hydrogen sulphide, susceptible of a removal by iron-oxide purifiers.

The preheating apparatus at the old plant being new and of the proper size, it was removed to the new plant and installed in the generator house.

REHEATING SYSTEM.

The two reheaters have a combined capacity of 4,600,000 cubic feet of gas per day. They were originally located at the old plant and after being dismantled, were moved to the new plant on railway cars and re-erected.

Each consists of a cylindrical shell 10 feet in diameter and 35 feet in height, and constructed of $^5/_{16}$- and ⅜-inch steel plating. Near the bottom of each is a 30-inch cast iron nozzle with hot valve for natural draft while heating; and also a 20-inch diameter connection with valve for the gas inlet. At the top is placed a 30-inch steel tee, which is firebrick lined, upon which the 20-inch cast iron stack valve rests. The gas outlet is off the side of this tee and consists of 30-inch steel pipe, also firebrick lined and which reduces to 20-inch diameter cast-iron, with clean-out ell and dip pipe to wash box.

The stack valve of each is operated from the main floor by a hand gear and connecting rod. A steel stack 5 feet in diameter and 20 feet in height is provided for each machine and is supported from the roof trusses, the same as those of the generators. The burners, of which there are four, are on the side near the bottom and each is equipped with control valves, gauges, etc. Several cast-iron doors also on the sides give access below the arches and to the checker brick filling.

The lining is 16½ inches in thickness and consists of 15 inches of firebrick and 1½ inches of asbestos fiber. It extends the entire length of the shell and is corbelled in at the top to form a crown and to support the lining in the 30-inch steel tee. Two sets of arches, with air spaces between and located one near the bottom and the other about half way up the shell, are installed for supporting the checker brick. In bricking on shell a total of 22,000 firebrick are used for the lining and 6,100 for checkering.

The wash box, which is used in connection with both reheaters is 8 feet by 14 feet in plan and 8 feet in height. It is constructed of ⅜-inch steel plating and is elevated on a steel platform, between and near the top and supported from the reheater shells. Water is admitted, through eight sprays distributed on the sides and the overflow consists of a cast-iron box and 10-inch pipe, which is sealed in a drain tank resting on the generator room floor. The two gas inlet connections enter at the top and are provided with 20-inch diameter dip pipes. The gas outlet, which is also at the top, is of the same size and extends to the condenser, which is located just outside of the building.

Gas Condenser for Reheaters.—The gas condenser was moved from the old works on a barge, with the purifiers. It is 12 feet in diameter and 22 feet in height and consists of a steel shell of ⅜- and $^5/_{16}$-inch plating. It is provided with two ⅜-inch tube sheets and 1,012 2-inch diameter boiler tubes, 18 feet in length. The gas inlet is at the top and the outlet on the side near the bottom, both of which are 20 inches in diameter. The water inlet is 6 inches in diameter and the drain connections to the sewer is 8 inches.

STATION METER AND WORKS HOLDERS.

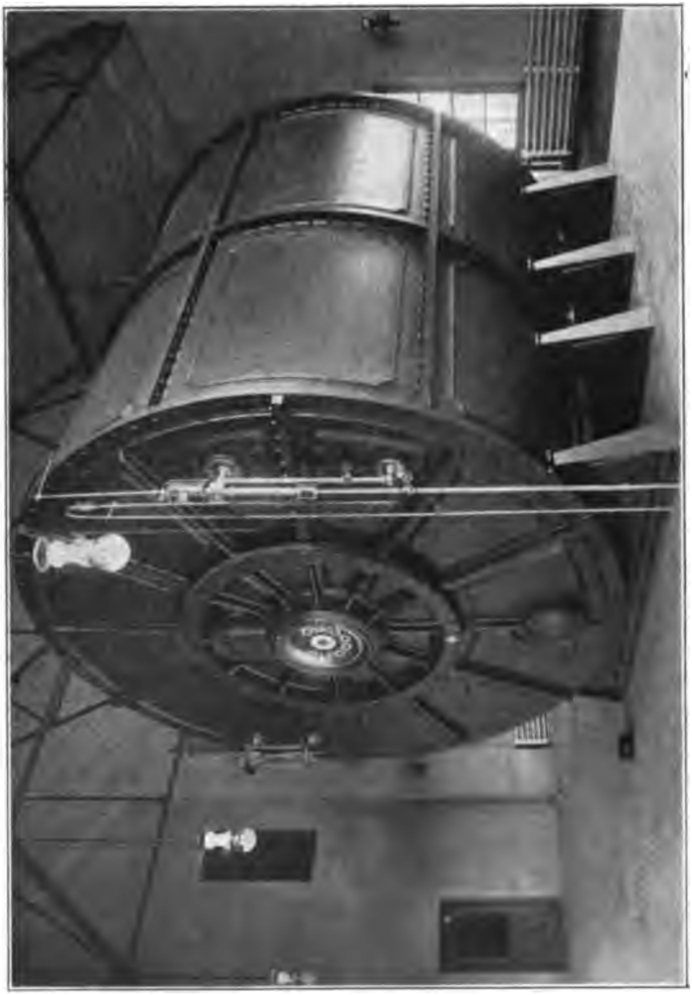
The gas, after purification, is measured in a station meter having a capacity of 4,152,000 cubic feet of gas per day. It is 16 feet in diameter and 16 feet long and has 24-inch diameter piping connections. It is a standard type, manufactured by the Charles H. Dickey & Company of Baltimore, Maryland, and is equipped with a cast iron casing, Hinman Drum and usual accessories.

The foundation consists of four concrete piers, one under each cradle. These piers are 2 feet 6 inches by 13 feet at the base and extend 5 feet below the floor line.

Holders.

Relief Holder.—The relief holder, which has a capacity of 680,000 cubic feet, has two lifts and is provided with new steel tank 113 feet in diameter and 37 feet in height. The holder was originally located at 13th and Couch Streets, and installed in a concrete and brick tank. It was dismantled and re-erected, using practically all of the old steel sheets and guide frames, and provided with new steel tank and stairway, extending to the top of the frame, which is 109 feet in height. The holder is equipped with hand rails on all stairways, along the cups and around upper lift and a Cutler's anti-freezing device is installed for protection in cold weather.

The foundation, consisting of concrete mat 4 inches in thickness at the inside and 12 inches thick around the outside, extends about 4 feet beyond the tank shell, forming a walk entirely around the holder. The outer edge of this walk is shaped into a gutter, which is arranged with sewer drains, the whole of which is similar to that of the storage holder. Concrete pits are provided for the inlet and outlet connections, including large gas valves and drip pots. Around these, hand rails are installed and where necessary steel platforms are placed for operating the valves.



STATION METER.

Storage Holder.—The storage holder, having a capacity of 505,000 cubic feet, has three lifts and is provided with a steel tank 94 feet 6 inches in diameter. A steel stairway extends to the top of the guide frames, which are 111 feet in height and hand rails are placed on all stairways, along cups and around upper lift. The holder is equipped with Cutler's anti-freezing device.

The foundation, which is 4 inches thick on the inside and 12 inches thick around the outside, extends about 4 feet beyond the tank shell, forming a complete walk entirely around the holder. At the outer edge of this walk, a concrete gutter is placed and is provided with sewer drains. The inlet and outlet pits are of concrete and are of sufficient size to receive the drip pots and large gas valves. Hand rails are placed around these pits and steel platforms for operating the valves.

GAS COMPRESSORS AND TRANSMISSION LINE.

Since the gas works are located some 7 miles down the Willamette River from the heart of the business district, it is of course not feasible to supply direct to the low pressure systems from the works holders. It is therefore possible and likewise advisable to transmit the gas from the generator station to the outlying storage holders at higher than street pressures.

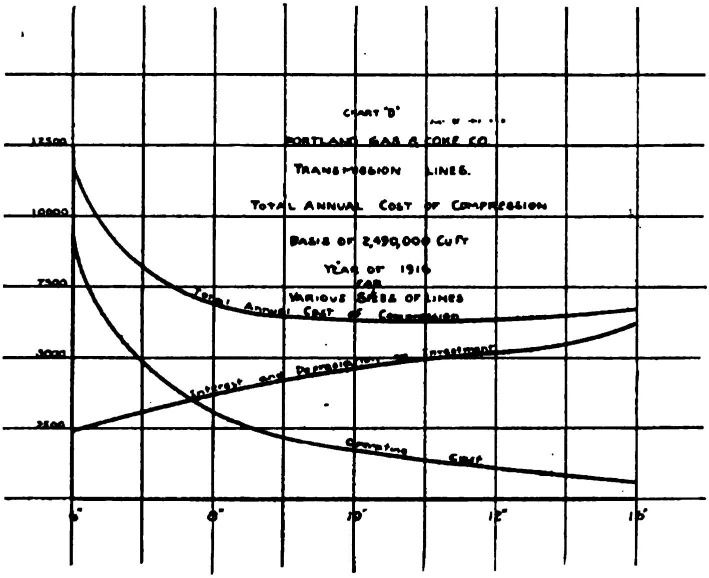
Calculations as to the growth of the city and the direction of growth furnished the basis for estimating the pumpage for a period of years. The size of pipe line was therefore selected in which the operating costs for pumping together with the fixed charges for investment would reach a minimum, after a period of a few years. The exceedingly low cost of producing power at the works and consequently costs of pumping made it possible to materially increase the pumping pressure and correspondingly decreasing the size of the pipe line. The calculations which were elaborate, indicated an initial pressure of 7 pounds for pumping through a pipe line 16 inches in diameter, to be the most economical. It was further indicated that when the growth of the company should necessitate a

GAS COMPRESSORS.

Cost of Pumping from New Works.

	1912	1913	1914	1915	1916	1917	1918	1919	1920
Output per hour, maximum	268,000	306,000	354,000	410,000	462,000	520,000	580,000	650,000	750,000
Interest and depreciation on 16-inch pipe line at 15 per cent. $190,000	$13,500	$13,500	$13,500	$13,500	$13,500	$13,500	$13,500	$13,500	$13,500
Cents per 1,000	0.930	0.815	0.705	0.637	0.542	0.480	0.430	0.383	0.383
Pumping pressure, pounds per square inch	4.5	5.75	7.5	9.5	11.5	14.5	16.5	19.0	24.0
Horse-power per 1,000	0.3	0.372	0.467	0.572	0.676	0.813	0.9	1.0	1.2
Cost pumping per 1,000 at ¾¢ per horse-power	0.225	0.278	0.35	0.43	0.507	0.61	0.675	0.75	0.90
Cost pumping per annum	3,262	4,600	6,700	9,550	12,600	17,150	21,100	26,400	36,500
Total cost per annum one 16-inch line	$16,762	$18,100	$20,200	$23,050	$26,100	$30,650	$34,600	$39,900	$50,000

pumping pressure of 16½ pounds, it would be economical to relay the transmission line. A chart and curve showing the calculations, are given below.



Gas Compressors.

The two compressors are duplex cross compound rolling mills Corliss units, manufactured by the Laidlow, Dunn, Gordon Company of Cincinnati, Ohio, and have a displacement of 5,600 cubic feet per minute, at 106 revolutions per minute, which is equivalent to an actual guaranteed capacity of 5,200 cubic feet at 94 per cent. volumetric efficiency at a mean pressure of 11 pounds. The high pressure steam cylinder is 13 inches in diameter, the low pressure cylinder 25 inches; the gas cylinders 31 inches in diameter and the common stroke is 30 inches. Both compressors are equipped for lubrication, with central glass oil reservoir, which is connected to the various lubricating points by brass piping and furnished with sight feed oilers. A governor is installed on the main steam connections and relief valves on the steam cylinders.

The foundation for each compressor consists of a concrete block 14 feet 6 inches by 24 feet 1 inch, in plan, and which extends below the basement floor.

The compressors are arranged to be operated either condensing or non-condensing. Each is equipped with a Worthington cylindrical condenser having 600 square feet of cooling surface and a single horizontal, direct action wet vacuum pump, having cylinders of the following dimensions: 8-inch diameter steam; 12-inch diameter air and 4½-inch diameter water and a common stroke of 12 inches. The condensers have a capacity each of handling a maximum of 7,500 pounds of steam per hour, when provided with 500 gallons of water per minute at 65° F. and the pumps, of displacing 50 cubic feet per minute at 45 strokes, or maintaining a 30-inch mercury vacuum in conjunction with the condensers. Both condensers and pumps are provided with gauges and thermometers; and the pumps with force-feed mechanical lubricating systems and other accessories for convenience in operating.

AUXILIARY EQUIPMENT.

Blowers.

For furnishing air to the oil-gas generators in connection with the heating process, it was decided to discard the positive-pressure type which had heretofore been in use for that purpose and substitute for the same the fan type. The reasons for this step were numerous. They may be tabulated as follows:

1. Adaptability to the electric drive.
2. Elimination of noise.
3. Ability to shut off air flow at generators suddenly without dangerous results to the machinery or the use of uncertain relief devices.
4. Lower first cost.
5. The realization that a sufficient volume of air for combustion could be delivered in the usual manner and at equal constancy, at a considerably lower pressure than commonly employed and well within the

GENERATOR BLOWERS

> limits of efficiency of a fan by the proper designing of air ports on the generators and the necessary air connections.

The General Electric Company having produced, about this time, their centrifugal air compressors, it was decided that this unit came nearest to realizing the advisability of compromising between the two types and was for this reason selected.

The four blowers are of the centrifugal type, two of which have a capacity each of delivering 7,200 and two each of 15,000 cubic feet of air per minute. They are manufactured by and direct connected to General Electric Company Type 12, Form K, 3,600 revolutions per minute induction motors, 50 horsepower for small blowers and 120 for large blowers. Each blower is controlled by a secondary switchboard near by and this consists of a pipe frame work, supporting the compensators, oil switches, etc.

Exhausters.

The same general comments, which have been made on the pressure type of air blowers, applies very well for the selection that was made of the exhausters. It was, however, with some misgivings that this type was installed for obvious reasons in connection with machinery of such small clearances and danger of stoppages. Our apprehensions, however, were entirely unfounded. This apparatus has operated with the most gratifying success since its installation, when it is realized that these exhausters have never been apart for cleaning in the three years since their installation. We have, on one occasion, for the purpose of easing our doubting minds, taken them apart, but this would not have been necessary.

In addition to serving the purpose for which it was installed the centrifugal exhauster has likewise achieved a conspicuous and lasting place as a final tar extractor, to the extent of rendering entirely superfluous the multiple gas washer installed as a final cleaner, immediately ahead of the purifier.

EXHAUSTERS

The two exhausters, which are of the General Electric Company's make, are of the centrifugal type and have a capacity each of handling 5,000 cubic feet of free gas per minute, against a normal pressure of 0.625 pound per square inch. Each is direct connected to, and mounted on same base plate with a 75 horse-power Type "I," 2-pole 3,600 revolutions per minute, 440-volt induction motor. The inlet and outlet connections are 14 inches in diameter; for cleaning purposes, while operating, connections for inserting steam for loosening the tar, have been installed, and for further cleaning and for access to the inner parts, one side of the exhauster shell is made removable.

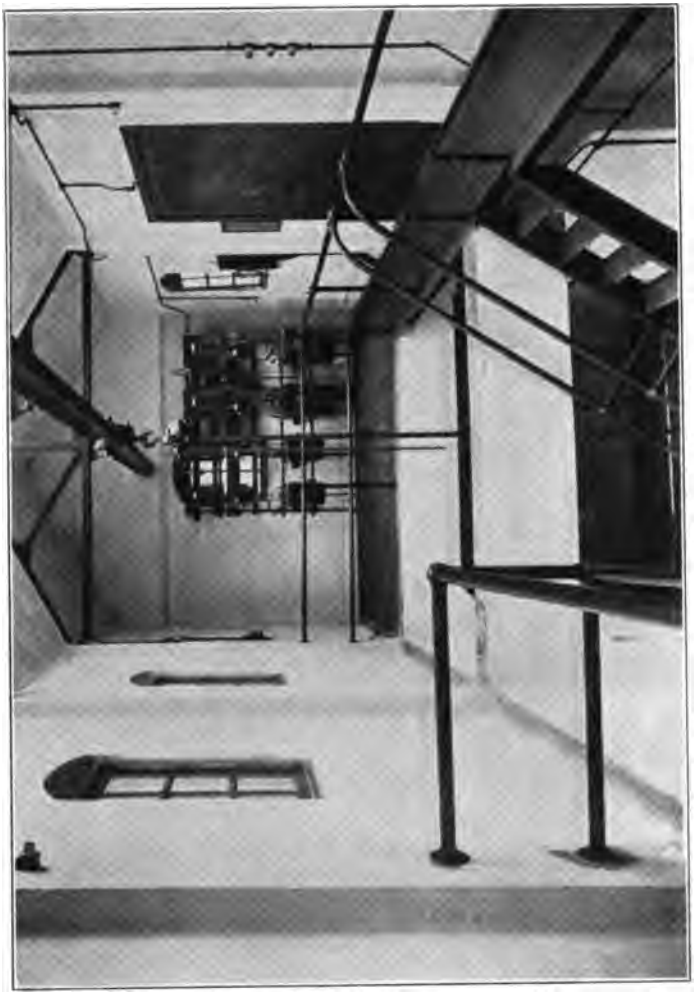
Each exhauster is controlled from secondary switchboard located near by and this consists of a pipe frame work, supporting the compensators, oil switches, etc.

Water Pumps.

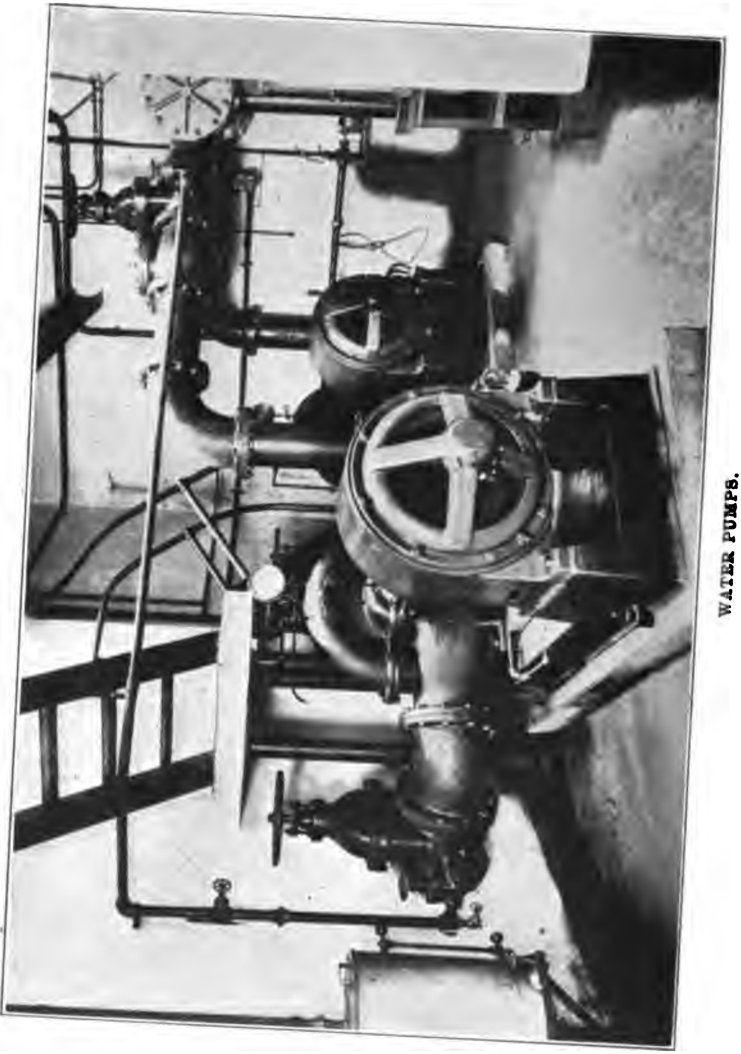
It can be easily realized from the remarks made under the description of the oil-gas process, regarding the essential necessity for the separation of carbon from tar pitch, that the water supply for an oil gas plant is the one item most deserving of attention.

Due to experience at our old plant, located in the heart of the business district, contiguous to the mouth of sewers and subject to the flotsam and jetsam from the wholesale district, an earnest effort was made at the new plant to overcome these conditions. Studies, which were undertaken prior to the designing of the new works apparatus, showed over 75 per cent. of the stoppages in operation to be due to a failure of the water supply. The pump house, which has been elsewhere described, was located as near to the river front as the soil conditions would permit. It was necessary to anchor this building to piling and to weight same down by a heavy mass of concrete to prevent flotation at periods of high water. At the same time it was necessary to thoroughly water-proof the building, since at various seasons of the year the operating units would be at a level considerably under that of the river.

PUMPING STATION AND OIL TANK.



PUMPING STATION CONTROLLERS.



WATER PUMPS.

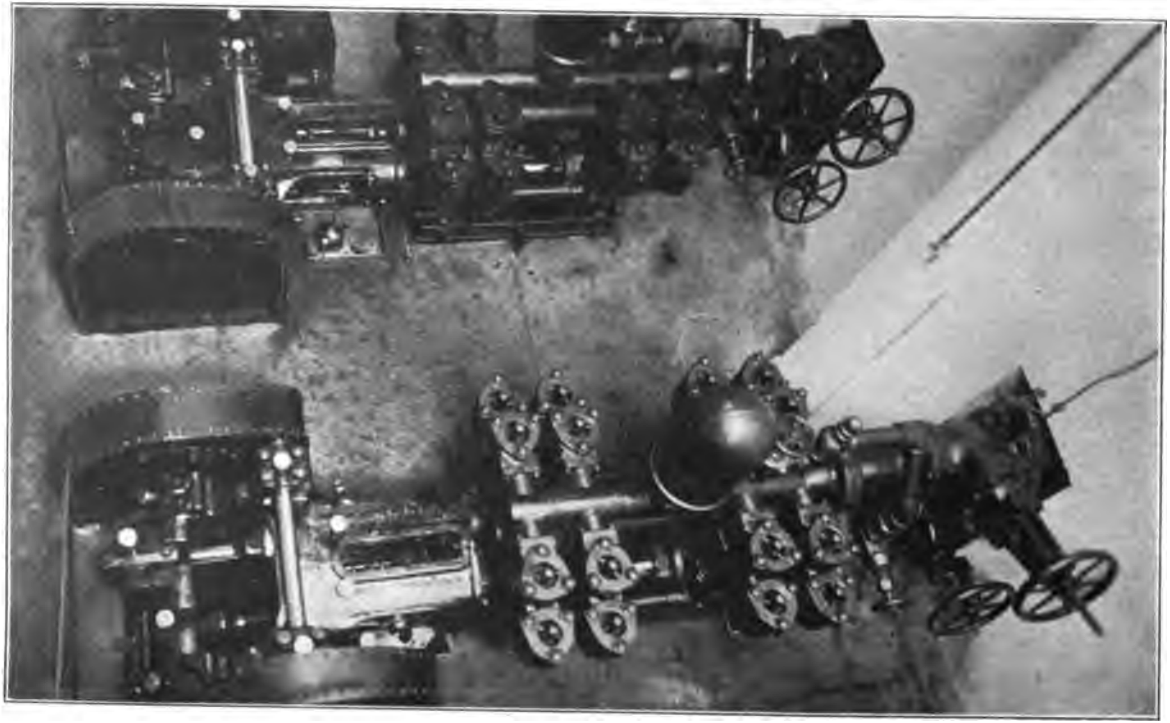
It was at once realized that a structure of this kind would be exceedingly expensive per square foot of floor space. It was, therefore, decided to double deck the machinery and likewise to locate same diagonally with respect to their suctions in order to economize space.

The lower deck was reserved for the water pumps, of which there are two installed, with room for two additional. The upper deck was for the use of the oil pumps, since the pump house is located in close proximity to the 55,000 barrel oil tank, and also because this weight of machinery insured additional stability to the building. Both stories are reached from the ground level by iron stairways and a crane pit. The latter insured easy removal of machinery and parts for repairs and consists of an I-beam at ground level, carrying chain blocks and trolley. Second, of an I-beam on the basement floor with a similar trolley. This second beam is hinged in such a manner that it can be swung to one side after the weight has been taken up by the upper chain blocks, to allow egress of the machinery.

The circulating water required for the condensers, scrubbers and other machinery about the plant is furnished by two 10-inch Jeanesville double suction volute pumps, located in the pump house. They are equipped with bronze impellers and each is direct connected by means of a flexible coupling to a 100 horse-power, Form K, Type "I"-6, 440-volt, 1,200 revolutions per minute, alternating-current electric motor.

Oil Pumps.

For supplying fuel oil for the gas generators and boilers, in the pump house are installed 4-inch by 12-inch duplex oil pumps, as made by the Dean Steam Pump Works. These have cylinders of the plunger valve pattern and parts exposed to pressure are subdivided as much as possible in order to overcome the necessity of replacing the entire parts. The pumps are each gear connected to one 10 horse-power, Type "I"-8, Form K, 900 revolutions per minute, 440-volt, alternating-current motor, and are equipped with gear covers, lubricators and other accessories.



OIL PUMPS.

Sump Pump.

In the pump house for removing the drips, drains, condensation and other leakages, a 1-pound centrifugal pump, as made by the Henry R. Worthington Company, and having a capacity of delivering 50 gallons of water per minute, is installed. It is direct connected to a 1 horse-power, Form "C," Type K. T. 4, 440-volt, 1,800 revolutions per minute electric motor, and is arranged to operate automatically with a float valve and switch.

Oil Storage Tank.

The oil storage tank is 116 feet 6 inches in diameter and 30 feet in height and has a capacity of 55,000 barrels. It is constructed of steel plates ranging from 3/16 inch to 9/16 inch in thickness and is provided with a roof of No. 22 gauge steel, which is supported by wooden columns, rafters and sheathing from the inside. It is equipped with 16-inch diameter swing pipe, which is operated by hand winch for the pump section and a 10-inch pipe line entering through the top, admits the oil from the steamers. A steel ladder gives access to the roof and a gauge consisting of glass tubes, vernier and scale, is installed for measuring the oil.

The foundation consists of a concrete mat 18 inches in thickness at the center and 24 inches around the outside. It extends beyond the steel work a distance of 5 feet 9 inches, entirely around the tank, and provisions, consisting of steel tie rods, extending up around the outer edge, has been made for the future installation of a concrete wall around the tank, as a precaution in case of leakage of the tank shell or piping connections thereto. As the tank rests on the low ground outside of the bulkhead, where it is surrounded by water during the high water season, in order to take care of any settlement or washing out of the sand and in event of installing a concrete wall to prevent the tank wall and foundation from being floated away, 470-40-foot piles were driven and these were securely fastened to the concrete mat by means of steel anchor bolts and tie rods.

One hundred eighty-six 40-foot piles have also been driven for the future installation of a 15,000 barrel oil tank, which is now at the old works, but the concrete for the foundation has not been placed as yet.

Water Tank.

The water tank, which has a capacity of 100,000 gallons, is erected on a steel tower, 50 feet in height. It is 28 feet 8 inches in diameter and 16 feet high, and is arranged with eliptical bottom and 3-foot diameter settling drum, extending to the ground. The tank is constructed of steel plates ¼ and 5/16 inches in thickness and has a conical roof of ⅛-inch plates, supported on steel framing. The tower consists of 12-inch channel columns, securely braced with struts and diagonal tie rods.

A steel spiral stairway, having ornamental iron hand rails and winding around the mud drum, gives access to a balcony with similar hand rail, which extends entirely around the bottom and, to prevent the tank from becoming full to overflowing, a 20-inch diameter overflow pipe has been installed. The water inlet pipe is also 20 inches in diameter and extends up into the mud drum a distance of about 5 feet, thus forming a settling basin around the pipe and for draining off the mud, a 6-inch diameter blow-off valve, with connection to sewer, has been provided.

The foundation consists of five concrete piers, one for each of the four columns and one on which the mud drum rests. These piers extend into the ground a distance of 6 feet and are 13 feet square at the base.

WORKS CONNECTIONS.

The large gas piping connections from the generators to the relief holder are 42 inches in diameter. From there to the exhausters, 36 inches and 30 inches to the purifiers, storage holder and compressors. Overhead piping is made of riveted steel and underground work is hub and spigot cast-iron with lead joints, and all of same has been tested with an air pressure of 50 pounds per square inch.

Oil Piping.

The oil line from the dock to the oil storage tank is 10 inches in diameter, at the dock connections are arranged so that the vessels can unload the oil at any stage of the river. From the tank to the pump house, the line is 16 inches in diameter, made of outside diameter tubing, having welded joints and branches from this consist of standard pipe and fittings. All high pressure oil piping is built for a working pressure of 250 pounds and have been tested to 300 pounds hydrostatic pressure.

All oil pipe lines under ground are covered with burlap and asphaltum and lines for hot oil have two layers of 85 per cent. magnesia pipe covering.

Water Piping.

The water main line from the pump house to the condensers and water tank is 20 inches in diameter. Branches from this extends to all buildings and machinery and also to twelve fire hydrants, distributed about the plant. Water lines outside of the buildings, consist of steel outside diameter tubing connected together with couplings, made by the S. R. Dresser Manufacturing Company. All water lines are built for and tested to a hydrostatic pressure of 125 pounds per square inch.

Tar Piping.

From each primary and secondary tar box a 6-pound pipe connection with gate valve is made and these are connected to an 8-inch main header, which extends to the tar pumps. From there a 6-inch line runs to the tar storage tank and a 4-inch line thence to the briquetting plant. All tar lines are designed for a working pressure of 125 pounds per square inch.

POWER PLANT.

Under consideration for a prime mover, were the following:

1. Steam.
2. Steam-electric.
3. Gas.
4. Gas-electric.
5. Oil.

Steam.—On account of the small size of the various units, which would not permit the use of high efficiency engines, and would necessitate long and scattered steam mains, no consideration was given to the individual steam drive.

Steam-Electric.—Involved the substitution of motor-drive for steam-drive, around the plant and a generation of current in situ from oil-fired steam boilers. This method was finally selected on account of cheapness of cost of construction and operation and flexibility.

Gas.—The individual gas-drive was not considered for the same reasons as the individual steam-drive.

Gas-Electric.—This form of drive presented the most powerful inducements. It was felt and is still by this company that the gas-electric-drive together with utilization of the exhaust heat for the production of steam, will eventually, by the high combined thermal efficiency, be adopted as the logical source of power for a central station gas plant. Unfortunately at the time this question was being considered and possibly even yet, sufficient practical progress had not yet been made in the utilization of exhaust heat for a plant of this size to be designed on other than experimental lines. Reluctantly, therefore, other prime movers were considered.

Oil Engines.—Diesel oil engines were given very considerable attention as a source of power, principally as on account of very low operating expense, construction costs were, however, at this time so high as to bar consideration of this type. Investment charges more than offset the operating economy. Moreover, the oil engine had not yet settled down to a standard design or a high degree of operating reliability.

Prime mover	Cost of install.	Annual opr. exp.	Per K. W. Hr.	Fixed Charges @ 15 %	Total apr. cost	Per K. W. Hr.
		3,066,000				
Steam-electric	62,900	K.W.HR.	0.72	9,435.00	31,520	1.027
		22,085				
Gas-electric	82,000	24,590	0.80	12,300.00	36,890	1.20
Oil-electric	135,200	11,172	0.38	27,040.00	38,212	1.24

Description of Steam-Electric Plant.—The units as finally selected were of such capacity that a single unit would serve the present and near future requirements for a gas plant of 7,500,000 cubic feet daily capacity and that by the future addition of a third unit, space for which was allowed, the capacity of the plant could be doubled without expensive alterations to buildings and equipment.

The schedule on the next page gives the principal data for the apparatus selected.

	Estimated	Actual
Current generated, kilowatt hours	3,066,000	3,176,736
Operating expense	$22,085.00	$14,926.00
Per kilowatt hour, mills	7.2	4.7
Kilowatt hours per barrel oil	180.0	228.0
Load factor, per cent	60	58

The preliminary estimates were considerably exceeded in the final selection of units and auxiliaries.

No expense was spared to make the power plant complete and efficient. The final result was that operating costs were 35 per cent. lower than estimated.

Utilization of Power.—A comparison is possible of the operating efficiencies of the various units by separate house type electric meters. At the present writing not all of the work performed is regularly measured, but this will be done at an early date. This applies particularly to the measurement of air and water.

All of the apparatus operating on gas, oil and steam are metered in such a manner as to afford daily and monthly quantity measurements, which taken together with measurements for electric current afford indications of the working efficiency of the various units which have been of invaluable assistance in the new plant.

The totalization of the individual meters is of great assistance in locating line losses in comparison with switchboard meters.

It is noteworthy that power unaccounted for, habitually amounts to less than 2 per cent.

The total energy consumed in the manufacture of gas, exclusive of that used for briquetting or transmission, is 1.9 kilowatt hours per 100 cubic feet of gas.

SCHEDULE OF POWER PLANT EQUIPMENT.

Number	Equipment	Kind	Size	Operating Condition
2	Turbo-Generators	Curtis Horizontal	500 K. W.	480 volts, 3 phase, 60 cycle, 3,600 RPM Gen. Elect. Co.
1	Turbo-Exciter	Type C. C.	35 K. W.	125 " 2 poles, 280 Amp. 3,600 " " " "
1	Motor Gen. Exciter	Motor Type 1	50 H. P.	400 " 3 phase, 60 cycle 1,200 " " " "
		Gen. Type DLC	35 K. W.	125 " 4 poles, 280 Amp. 1,200 " " " "
1	Switchboard		12 Panel	T. A. Regulator " " "
2	Condensers	Surface	1,635 sq. ft.	Utilizing water supply to Gas Gen. H. R. Worthington
2	Pumps	Vacuum	8″x14″x18″	$29^1/_2$″ Vacuum " "
2	Pumps	Hot Well Duplex	6″x$7^1/_2$″x6″	" "
2	Pumps	Vertical Duplex Piston	10″x7″x10″	Utilizing superheated steam " "
1	Heater	Vacuum feed water	2,000 H. P.	Utilizing exhaust steam Blake-Knowles
2	Boilers	Horizontal Water Tube	300 H. P.	200 lb., pressure 100 deg. super heat Babcock & Wilcox

BRIQUETTING.

In the manufacture of illuminating gas from crude oils produced on the Pacific Coast, a quantity of very pure carbon is practically the only residue. The amount of the carbon varies from 20 to 30 pounds per 1,000 feet of gas made, or is equivalent to 2 to 3 pounds per gallon of crude oil used.

This carbon is deposited in a partly amorphous and partly graphitic form during the process of cleansing and washing the gas. It can be recovered in the wash water, which contains from 1 to 2 per cent. by weight of lampblack.

In early history of gas making, this carbon was allowed to settle out in large vats, whence it was shoveled out by hand labor. The art was subsequently improved by the use of filters, consisting of a rectangular tank containing the lampblack water, in which revolves a wooden cylinder constructed in various sizes from 10 to 16 feet in diameter, the axis of which is horizontal, and the two ends of which are open. The drum is constructed of fir or redwood staves which are pierced radially by pipes acting as spokes, which are in turn connected with a hollow trunnion.

The exterior of the cylinder is covered with wooden strips dividing the surface into sections, covered with galvanized iron mesh and several layers of burlap and duck canvas, the whole being tightly wound with galvanized wire wound on spirally with the strands about 1 inch apart. The trunnions are fitted with automatic valves, which alternately make contact with compressed air ports and vacuum ports, which communicate to tank receivers. These tanks are connected at the bottom to centrifugal water pumps, and at the top to ordinary vacuum pumps.

The operation of the apparatus is as follows: That portion of the drum which is submerged is in communication with the vacuum ports. The section draws through the canvas large quantities of water, leaving on the exterior of the canvas the suspended lampblack. As the drum emerges from the water, the vacuum connection is continued; but air penetrates through

BRIQUETTE PLANT.

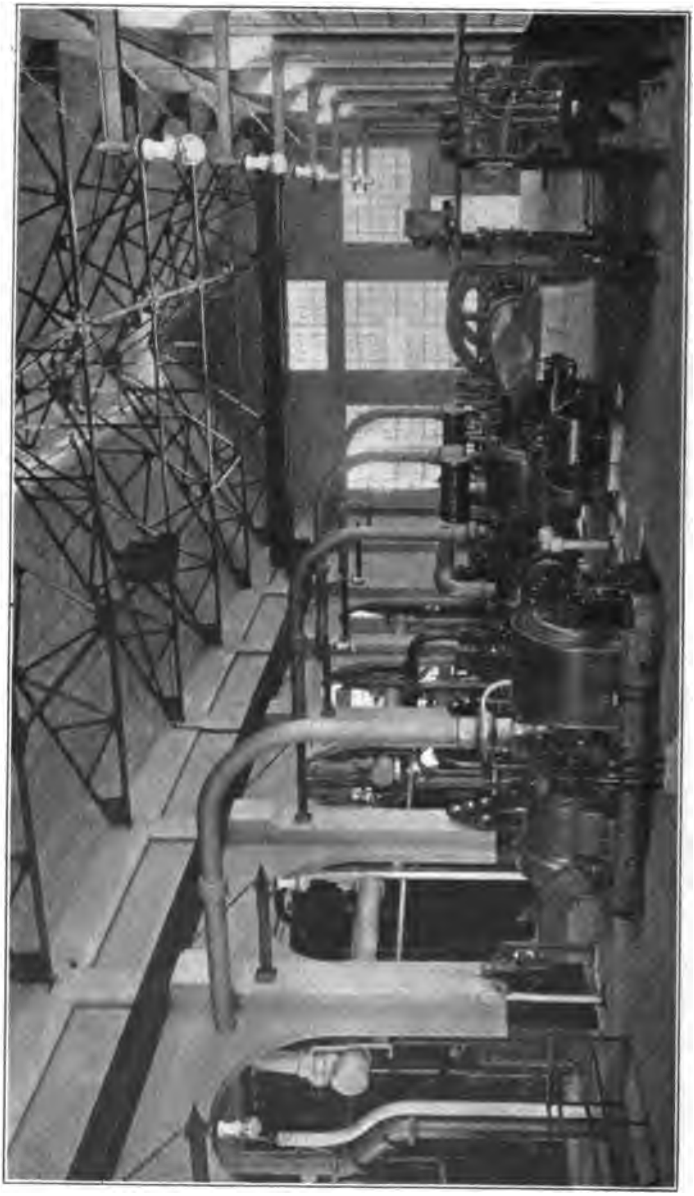
the lampblack and partially dries it. Then a further turning of the wheel breaks the connection with the vacuum ports and makes the connection with the compressed air ports, which happens just before the drum is about to submerge itself again. At this point the drum is in contact with a sheet-iron scraper, resting lightly on the surface of the wires. Through the combined action of the air blast and the scrapers the lampblack is removed from the surface of the drum.

There are four units of the type at the Portland Gas & Coke Company's plant, each 16 feet in diameter, and having a capacity of 1,000 gallons of water per minute. The units are motor driven and placed two on each side of a 36-inch belt conveyor onto which the scrapers discharge. The belt conveyor passes immediately in front of two 50-ton rotary driers provided with worm feed and plow shaped scrapers resting on the conveyor belt. The vats which contain the lampblack water are made of reinforced concrete.

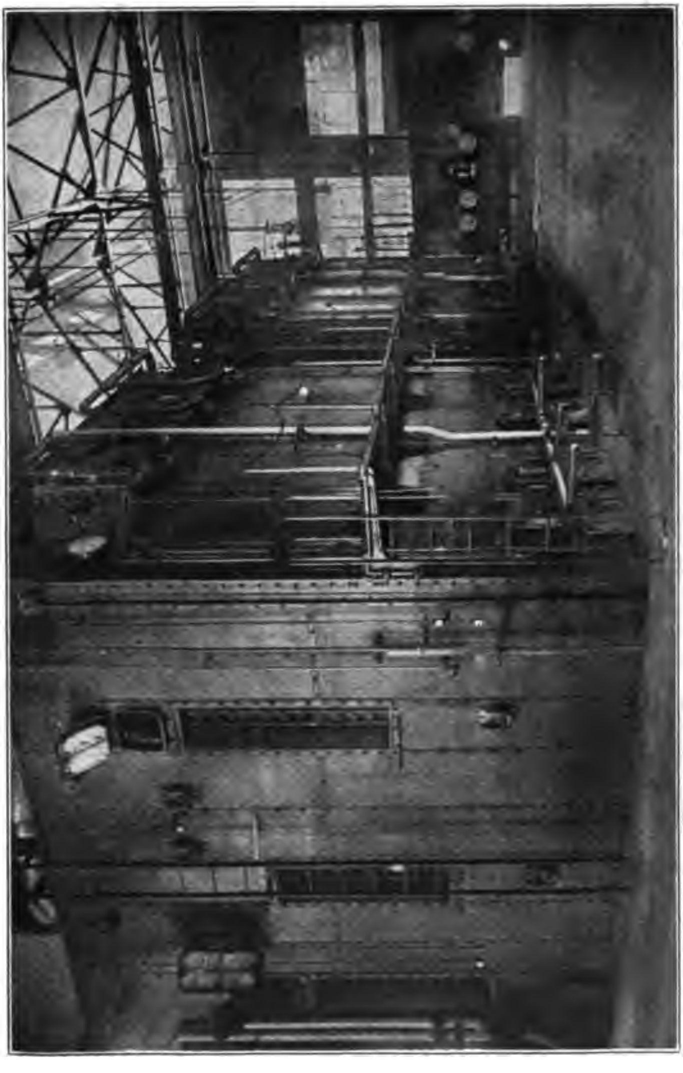
The driers are similar to rotary cement kilns. They are provided at the front, immediately under the feeds with Dutch-oven furnaces for firing with wood, and with 60-inch exhaust fans running at 900 revolutions per minute, handling about 12,000 feet of air per minute, and connected likewise at the front of the drier, the front plate of which makes a sliding contact with the drum. The drum is set on a slight incline, and the progress of the lampblack is from front to rear, where it is discharged by gravity. The path of the fuel gas is under and around the drums, entering at the rear and passing through the drum into the fan duct at the front.

Both driers feed into a single bucket elevator, discharging into an overhead hopper, which is supported directly on the frame work of a 50-mould briquette press, designed especially for the briquetting of lampblack. The press operates at about 7 revolutions per minute, producing about 50 briquettes per revolution.

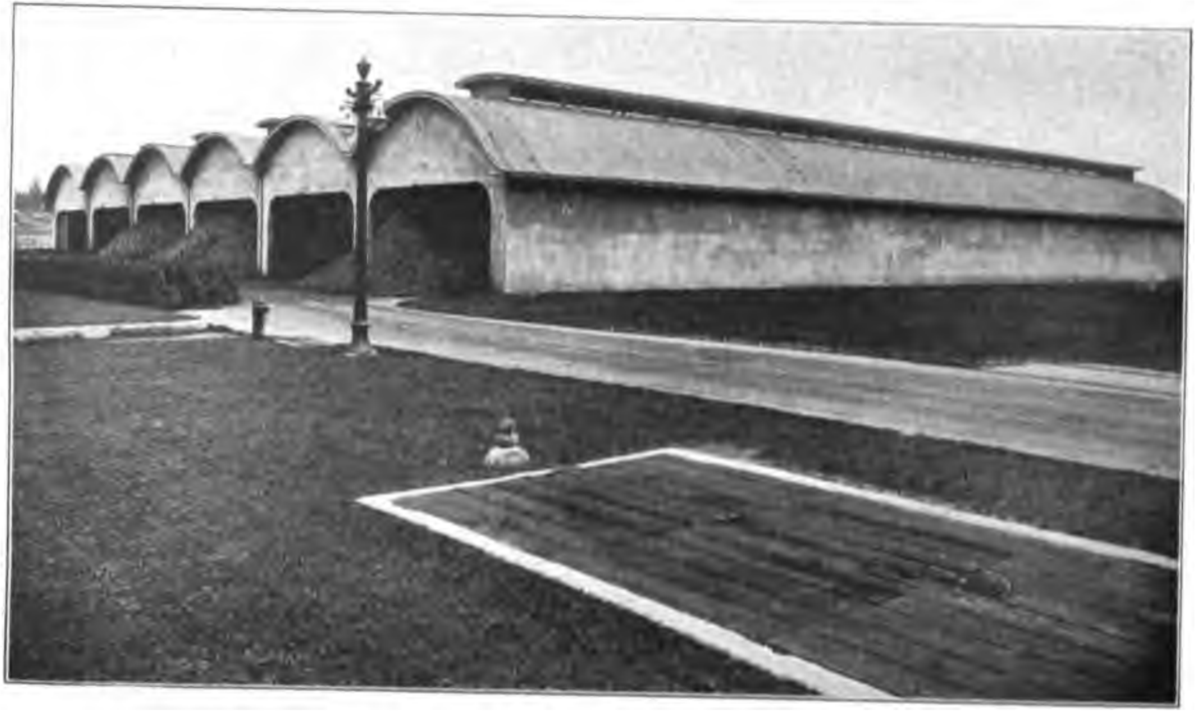
The press consists of a bronze mould board containing 50 moulds, 2¼ inches in diameter, which is fitted to receive top and bottom plungers actuated by cams and connected by means



POWER PLANT.



BOILER ROOM.



BRIQUETTE STORAGE SHEDS.

of a set of gears and clutch to a 35 horse-power motor. Compression of briquettes is by means of simultaneous action of top and bottom plungers. The filling and discharge of the moulds is accomplished by means of a reciprocating horizontal mould board, continuously fed with lampblack from the overhead hopper.

The briquettes as produced are discharged immediately onto a short rubber belt conveyor, gear driven from the press itself, and discharging onto a system of unit conveyors for the purpose of storage.

They consist of 12 sectional conveyors, each equipped with its individual motor, and overlapping end to end. The last one in series is known as a stacker, and consists of a belt conveyor operated at a steep angle, and which may be lowered or raised or moved from side to side as desired.

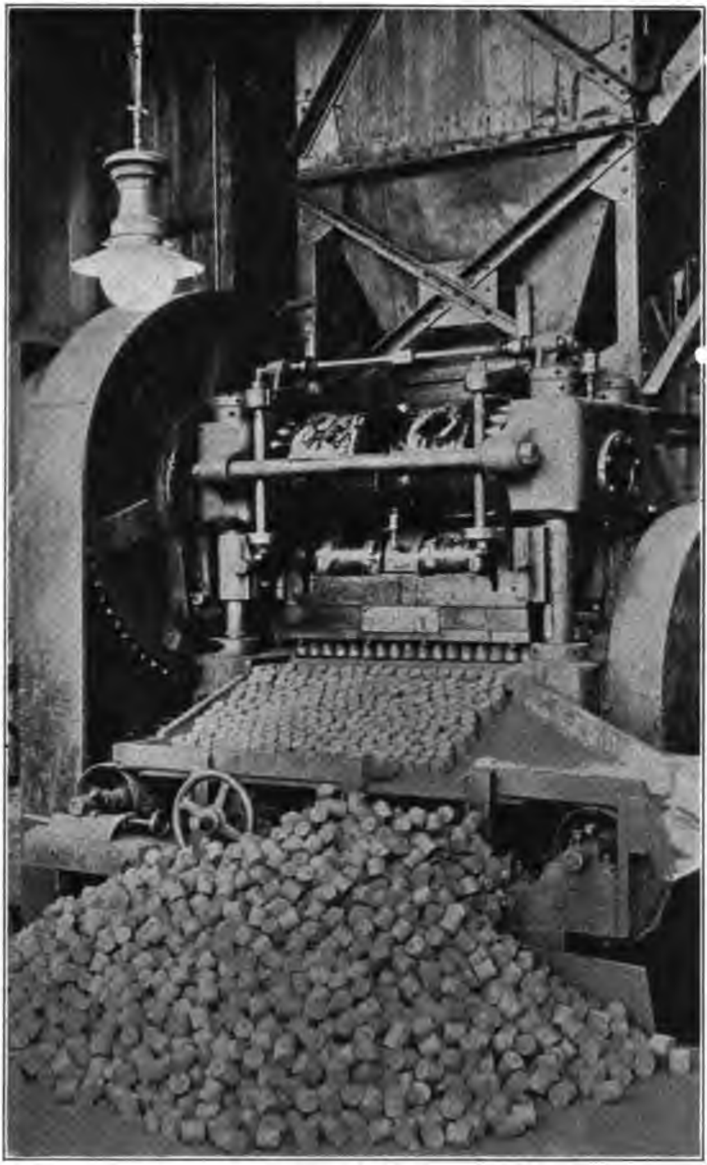
The process of briquetting is as follows: The lampblack as recovered on the wheel is dried to a percentage varying from 45 to 52 per cent. of moisture. The material is continuously recovered on the wheel is dried to a percentage varying from gas plant, there being no storage provided for the carbon water; in other words, the carbon water is treated as fast as the gas is made.

The gas works has a present capacity of 50 to 75 tons of carbon per day. This quantity is continuously discharged onto either one or two driers and dried to a moisture content of from 12 to 15 per cent. No binder is used, since the volatile matter naturally present in lampblack, which is of a tarry nature, is sufficient for this purpose.

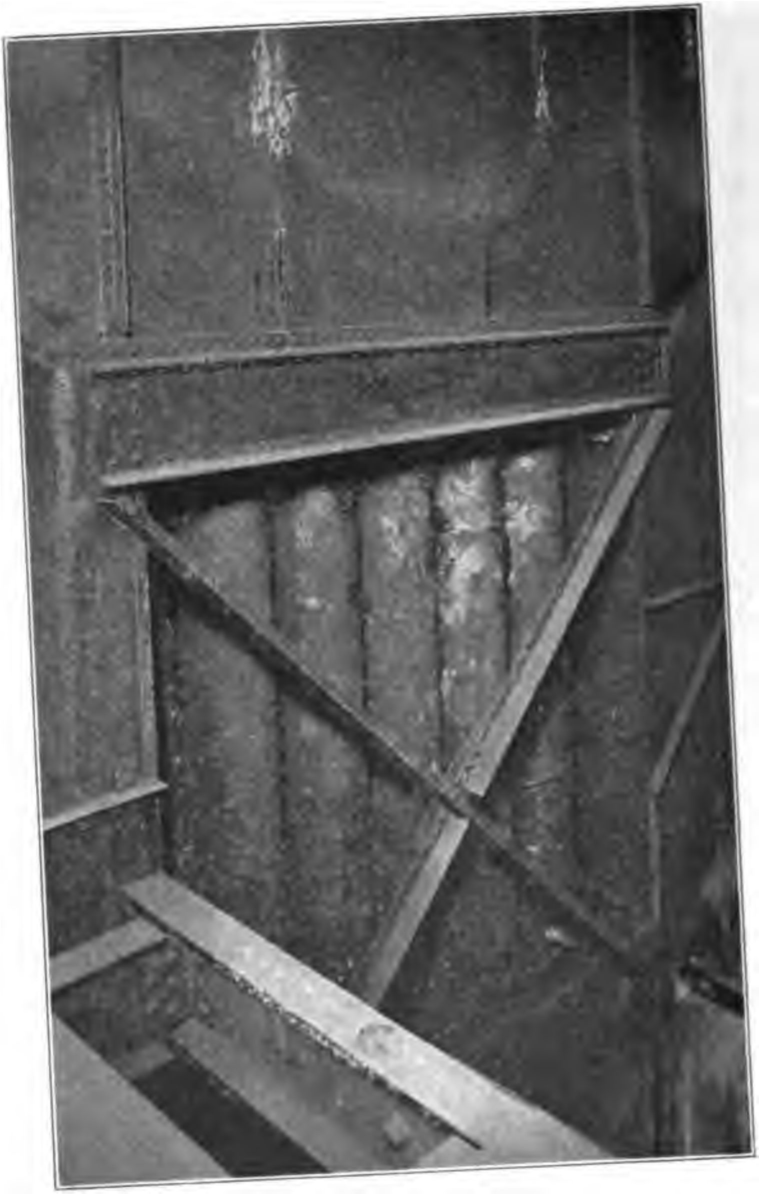
Continuous Process.

The drying, unfortunately, is accompanied by a certain amount of yellow smoke, consisting mainly of hydrocarbons of a tarry nature. This smoke is of a very persistent nature, and at one time brought complaints from adjoining property owners. The smoke is not susceptible to being treated or washed in a similar manner as chemical fumes, since it is not

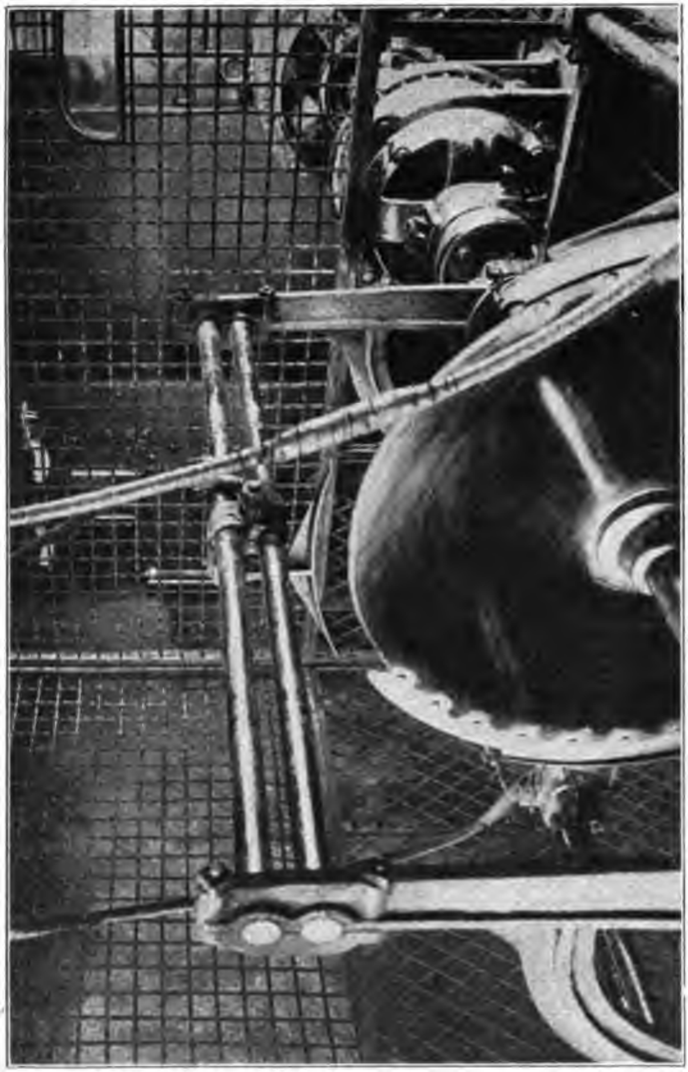
FILTER WHEELS.



BRIQUETTE PRESS.



SMOKE TREATER.



APPARATUS FOR RECTIFYING HIGH TENSION CURRENT.

soluble and is present in a vesicular or fog form. After considerable experimentation, the problem of obviating this nuisance was accomplished by treating the smoke by high potential electric discharges, in a similar manner as the Cottrell process used in treating smelter fumes. But little power is required for this purpose, and the results are remarkable.

The dried lampblack is continuously discharged from the conveyors and continuously briquetted. The hopper over the press has a storage capacity equal to about 1 hour's run, which is sufficient for the ordinary attention to the press. The briquettes produced are cylindrical in form and 2¼ inches high. They are quite hard and will bear considerable handling. Owing to the irregularities of operation, etc., there is at times considerable dust produced, and for this reason, all briquettes are screened before selling. Inasmuch as the briquettes are pressed with a very low percentage of moisture, extensive drying or curing is not needed before selling, a couple of weeks being ample time for this purpose, at which time the moisture content has been reduced by evaporation to 5 or 8 per cent.

Same Price as Coal.

Briquettes are at present delivered by trucks to all parts of Portland, and, inasmuch as the gas plant is located about 7 miles down the Willamette River from the center of the city, the expense for transportation is quite an item. The briquettes are sold on a sliding scale, ranging from $7.00 to $9.50 per ton, with a 50 cent reduction in the summer months. They are used for all purposes that coal is utilized, including domestic use and steam raising in apartment houses.

OPERATING EFFICIENCIES.

The new plant effects a saving over the old plant approximating $45,000.00 per annum, or practically 15 per cent., accounted for principally in fuel and labor.

THE CHAIRMAN: The paper is now open for discussion. Unfortunately this paper did not reach the Secretary far enough in advance of the annual meeting, to enable us to send out advance copies and in that way secure discussion. We have one written discussion which will now be read.

MR. C. O. BOND (Philadelphia): (Written discussion communicated.) On page 361 there are given the two points kept steadily in mind in designing the Portland works, and it is to the second of these that I wish to draw attention, particularly as Mr. Hall has been so modest in statements as to his success in achieving his second aim; namely, "to eliminate what had heretofore been the principal source of complaints against the operation of a gas works, namely, soot, dirt, smoke, cinders, etc., together with the untidy appearance of things and the gloomy, grimy and ugly buildings."

The photographs give some impression of the architecture, and natural setting of the buildings, and the plans give an accurate idea of the arrangement and relation of the buildings and apparatus one to the other; but these cannot adequately voice the impression that a visitor gets who has come with the idea of seeing the usual gas plant.

The telltale trail of smoke is missing as one approaches; the idea occurs that possibly the plant is shut down, but if so the coke or rather briquette business is moving briskly, for truck after truck of these motor by on the way to Portland. A nearer approach brings a high singing sound; this is found to come from the high speed fans and motors. Every expenditure of energy is applied as needed and for a specific purpose, and a separate meter records it. The results come in every morning and the energy rquired for each operation is known. No wonder less than 2 per cent. is unaccounted for!

I do not remember seeing another plant where the power room could use its ceiling for indirect gas lighting as is partially done here.

The sense of cleanliness and orderliness gets into the blood and temperament. There is a constant challenge whenever a new piece of work is to do, that it also shall be done not in *a* way but in *the* way which has become habitual in the environment. If a machine can do it then develop or obtain the machine, and get as much as possible of the operation automatic. The small number of men about is noted

After a trip over the entire plant with increasing elation over the fact that *" it can be done in a cleanly way"* your faith wavers and one more question forced by habit comes to the surface, "Won't you now show me the dump?" The host looks at you queerly with something of commiseration in his face and says, "Yes, but can you not understand, there *is no* dump!" And it is a fact. You cannot find it underground nor on the surface, nor in the air. *It is a clean plant.*

In the effect which it has wrought on the morale of a plant do I find a chief benefit flowing from this particular attention paid to design and operation. I take off my hat to the medicine man of Portland whose treatment does one good.

Upon motion, a vote of thanks was adopted for Mr. Hall's paper.

The Chairman: We will go to the next paper, the report of the Committee on Standard Tests, presented by Dr Wing.

Dr. J. F. Wing (Everett, Mass.): Mr. Chairman, remarks made here yesterday would well serve as a preface of this report.

(Dr. Wing abstracted the printed report of Committee on Standard Tests.)

REPORT OF THE COMMITTEE ON STANDARD TESTS.

It has been the task of this Committee to comply with an insistent demand for comparable or uniform methods of stating the results of testing or, more broadly, the results of operating a manufacturing unit or plant. The object of this standardization is to facilitate the study of the efficiency of materials, apparatus and methods by comparing the results obtained at different times and places. This object is most nearly attained when the operation and results are reported in a comparable manner.

The task which the Technical Committee set for us, would not be very hard for anybody to do to his own satisfaction. All gas companies have their own forms and methods, more or less complete, and it is this very diversity and independence which creates the demand for standardization in reporting those data which are of interest, and profitable to compare. This diversity of practice makes the committee diffident in expecting its recommendations will be wholly acceptable to all.

The field covered by this report is already large, too large perhaps, and still other details might be included. Since it contains the views of so small a number and the subject is so important, it is offered to the Institute this year as a preliminary report for criticism and for instructions.

In the early days of gas associations, and even in the earlier prehistoric days, when two or three gas men were gathered together, there would be one among them who would modestly mention the high candle-power he was getting. Then another, whose candle-power was not so high, would complacently inform them about the large yield of gas per pound of coal, which he was producing, and both parties were probably content with their results.

Now, of course, if the physical conditions of the measurements were ignored, their flattering results might not be even true; and if the conditions of operating were only casually noted, it would be difficult for another to divine the reason for the success in some works and to discover the faults in his own.

Many of us can remember how ingeniously the expression "candle-feet per pound," when he first heard it, seemed to reconcile the relations of quality and quantity.

Although changes and improvements were continually taking place, the summary "candle-feet per pound of coal" answered very well as long as good coals were widely available and the annual reviews of the state of the art reported that "there has not been much progress in carbonization," which was not so very long ago, and a production of 80 candle-feet per pound was satisfactory.

This state of affairs changed when in consequence of the poorer quality of much of the gas coal used, and the adoption of improved designs, it became realized that the range in candle-feet per pound extended from 70 to 100, and that the by-products varied quite widely in quality and quantity.

We have in the manufacturing results in water gas plants, also a wide variation at different times and places.

The art of gas manufacture has improved so much, and the urgency of economy is so great, that it is important to study these reported variations in efficiency, and to note the conditions under which they are obtained.

If this collection and exchange of information is to be most productive, it must be carried out quite extensively and in a uniform manner. This necessity has given the impetus for preparing a standard scheme for reporting conditions and results.

It is important to record just what you are doing when you are doing well, so that the same conditions may be followed again. High results are due to close control. Besides, there are still many points in the art which are not understood and which we are hopeful of elucidating. Then again, when some other plant is doing better than your own it is convenient to have a common basis of comparison, and not infrequently, to satisfy yourself that it is doing better.

The most urgent necessity of standardization seems to have arisen within a few years on account of the improvements in manufacture and the different designs of plants. In order to meet changing commercial conditions, and to supply an increased demand for gas, most companies have been expanding or rebuilding the plants, or installing new ones. Some have been enterprising enough to install novel designs after studying plans. But many more have cautiously tried to select an installation after inspecting and comparing the cost and efficiency of several operating plants and have been puzzled over the question of efficiency of production, which is influential in determining a choice, owing to the unfamiliar, or it may be, the incomplete methods of recording the materials used and the results.

Here is a case where comparable and reliable data assist in determining a considerable investment, and in confirming the claims of competing advocates, whose good faith is not questioned.

These designs may be all good in their own peculiar way, that is, superior for some special objective.

The usefulness of this code is for conducting and reporting tests. The form is recommended for reporting manufacturing data. It is profuse and even complicated in detail and still might be extended. But is is thought that any of the data called for might be desired and considered of influence.

Some of the observations may be infrequent. Thus the data not easily subject to change may be taken day and night; but variable data should be observed hourly during a test. In routine manufacturing reports many items could be omitted, but they should be remembered as points of attention for the proper management of the plant.

"Note the specific object of the test, and keep this in view not only in the work of preparation but also during the progress of the test, and do not let it be obscured by too close attention to matters of minor importance. Whatever the object of the test may be, accuracy and reliability must underlie the work from beginning to end.

"If questions of fulfillment of contract are involved, there should be a clear understanding between all the parties preferably in writing as to the operating conditions, which should obtain during the trial, and as to the methods of testing to be followed unless these are already expressed in the contract itself."

The purpose of a test of a plant or a unit may be to determine the efficiency of the apparatus itself while using familiar materials, the materials in a familiar apparatus, or a variation of the method of operating.

Now any one change in the materials or method of operating involves a long chain of changes in the conditions, which might be illustrated in several ways. Therefore, in order to obtain any valuable and tangible information many data of conditions must be taken, since it is difficult to ascribe the proper cause to an effect.

The scheme does not provide for reporting costs of labor or repairs. These are details of management. They would be apt to be high anyway in a test run for large results.

The test must be preceded by a thorough examination of the plant or apparatus concerned, in order to be certain that it is in good order and that all defects may be remedied, thus avoiding interruptions and the opportunity for deceiving results in a test for efficiency.

Leaks in apparatus, connections, piping and especially valves must be corrected, obstructions in flues and connections sought and removed. All seals and drips must be put in working order. All mechanical apparatus must be inspected and put in order.

The person in charge of the test should have the aid of a sufficient number of assistants so that he may be free to give special attention to any part of the work whenever and wherever it may be required. He should make sure that the instruments and testing apparatus continually give reliable indications and that the readings are correctly recorded. He should also keep in view at all points, the operation of the plant under test and see that the operating conditions determined on are maintained and that nothing occurs either by accident or design to vitiate the data. This last precaution is especially needed in guarantee tests.

A memorandum should be made of every unusual condition and occurrence with the exact time. All observations must be recorded promptly and faithfully in a permanent manner with the time noted on the log sheet, signed by the observer.

In the chemical tests of materials and products, as well as those made for the control of operations, it is recommended that the methods of sampling and analysis proposed by the Committee on Chemical Tests of the American Gas Institute be followed.

In the observation of the data of the physical tests made on the operation or on the products, it is important that all the standards and measuring apparatus should be known to be accurate, within narrow limits. It may seem perfunctory to utter this caution, but often too much confidence is placed in the condition and accuracy of apparatus. Many different instruments have to be used to take all the observations scheduled, some are liable to error for more than one cause, and not the less if they are used infrequently, so that it is not impossible that a critical examination will expose something. This applies to everything from the platform scales to the calorimeter.

The result of the test of a plant is the sum of many factors. If some of the factors are incorrect, one may wonder for 24 hours, at the results of a 24-hour test.

The length of time to be taken for a manufacturing test must be determined by the discretion and convenience of those interested. One week would appear to be the shortest duration which would give satisfactory and valuable information. If this short period is the limit great care must be taken to avoid unusual conditions, in order to prevent self deception, which is not so probable in a longer test.

It must not be understood that one week is sufficient duration for a serious test of a carbonizing plant. But such a period will give information concerning a variation in the method of operating a water gas plant, and also concerning a variation in the generator fuel, and in coal used in carbonizing apparatus, when the manufacturing conditions are unchanged.

A carbonizing plant responds more slowly than the other to changed conditions of operating on account of the large mass of heated material, therefore it requires much longer to evolve the best conditions for operating the fires and to determine the best conditions for carbonizing the coal.

A further reason for extending the test of a carbonizing plant over a long period is that large quantities of coal are used daily from the storage, and there is much probability that the coal will not be uniform in its condition and even not be from the same source or shipment all the time. Hence too short a period of test may be misleading.

If the object of a guarantee test is to produce a large volume, a period of one week is too short, since it is possible to run that length of time at an abnormal and imprudent intensity, which could not be continued without danger of injuring the setting. Permanency and reliability are important to be proven.

A carbonizing test should extend a month or longer. In a new plant if it is to be a guarantee test, it should not be undertaken before the plant has run long enough to be in normal operation. Formerly when the retorts were all horizontal and rather lightly charged, a month would include the scurfing or burning out time, nowadays it would hardly occur so often. A month is about the shortest period for which the residuals tar and ammonia can be determined satisfactorily. Also, in case a residue of coal must be measured, there is less per cent. of error after a long period.

A water gas plant should be tested for one week or longer. In this case the efficiency may be determined more quickly, but the workmanship and reliability must also be assured.

It is not necessary to expand this report by including in it directions for testing the quantity and quality of the gas. Authoritative and minute directions for testing station meters are accessible to the Institute members in the Gas Institute *News* for December, 1915, p. 528.

Directions for candle-power observations are given in the valuable report of the Committee on Methods of Taking Candle-power of Gas, published in the PROCEEDINGS of the

American Gas Institute for 1907, and in a supplementary report in the PROCEEDINGS for 1908.

The calorific value of the gas in British thermal units should be determined by following the explicit and practical directions, adopted in 1910 by the Joint Committee on Calorimetry for the Second Public Service District in New York, as nearly as circumstances will permit. These regulations were published in the report of the Joint Committee in 1913 and were printed in the PROCEEDINGS of the American Gas Institute for that year.

These directions are based on the work of the Committee on Calorimetry of the American Gas Institute, which was reported in 1908 and 1909 in the PROCEEDINGS. These reports, in pamphlet form, may be obtained from the Secretary.

If a handbook on testing is issued, these directions will be included.

BY-PRODUCTS.

When we turn from the elegant and accurate methods of determining the quantity and quality of the gas produced, to consider the by-products, coke, tar and ammonia, we find some difficulty in obtaining satisfactory measurements.

Tar and Ammonia.

The tar and ammonia are usually collected in large tanks already containing these products so that reliable measurements cannot be made when a short test run is carried out. If these are the conditions, the test should continue long enough for the tar and ammonia collected to amount to so much that a slight error in measurement would not make a large percentage of the quantity.

In order to obtain reliable measurements from a short test, separate tanks of small size must be available. Both of these by-products must be tested chemically in order to determine the actual tar and ammonia.

Coke.

The coke made and used as fuel should be reported as dry. When a test, which is of some importance is being made, it all should be weighed, although it is laborious and inconvenient to do so, by some method that can be adapted in the plant.

When the object is to check the production of coke in continuous manufacture, it is out of the question to weigh it all, but periodic weighings should be made to check the measures of yield, breeze and fuel.

The coal carbonized and the water gas generator fuel should be weighed, all the time, either as car loads or as smaller units.

So far we have used the term "coke" in a general sense. In practice it seems desirable to use these definitions. Coke is that portion of the entire product discharged from a retort after carbonization which will pass over a screen having ½-inch square openings.

Breeze is that portion which will pass through these openings.

This distinction is somewhat arbitrary, although it is quite widely accepted.

It is important, for purposes of comparison, that it be specified how the coke should be screened. In practice and commercially, different plants use rotary screens, shaking screens and screens inclined at different angles. These modifications are equivalent to openings of different sizes and are further influenced by the rate of screening.

Take the coke immediately on discharging before it is subjected to other handling. Enough lots should be taken to have samples representing actual conditions. In horizontal and inclined retorts the coke from a vertical tier must be taken; from vertical retorts and ovens also, it must be taken from several, in order to include all conditions. It is recommended that the coke be forked, then thrown on a ½-inch screen, 3 feet wide by 6 feet long, inclined at an angle of 40° from the horizontal.

Yields of Coke and Breeze.

In order to make the reported yields comparable, it is desirable that the calculations should be made on a basis of dry coke and dry breeze from dry coal. The total product from the retorts on which the determination is to be made should be screened to separate the merchantable coke from the breeze. After screening, the weights of coke and breeze should be determined. Samples of both coke and breeze should be taken immediately after the product has been weighed and moisture determinations made thereon. From the result of these moisture tests the total number of pounds of the dry coke and of the dry breeze should be calculated. The yield of dry coke from dry coal is then calculated by dividing the total number pounds (or tons) of dry coke produced by the total number of pounds (or tons) of dry coal charged in the retorts which were used in the tests.

The net dry coke does often agree in percentage with the result of the crucible test of the coal, but the only way to obtain reliable figures for the yield is to weigh that produced in the operation.

There are some properties of the coke which are important to be noted. The chemical composition is called for in the schedule for reporting the tests. Certain physical properties are important in deciding whether a coke is suitable for service where the most exacting requirements of its quality are demanded, that is, in a blast furnace.

Therefore, the coke may be subjected to several kinds of tests to determine its character.

1st. The shatter test to determine its relative breakage on handling.

2nd. The porosity test.

3rd. The specific gravity test.

4th. The crushing test.

5th. The test for solubility in carbonic acid at high temperatures.

Of all these tests, the results of only the second and third can be expressed absolutely.

The shatter test can be made quite satisfactorily, both as to simplicity and consistency in the results, and gives perhaps the most information about its physical value, since if it is relatively resistant to shattering, it must be quite tough and dense, more suitable for transportation and for ordinary fuel purposes.

The fourth and fifth tests have been studied but have not been developed so that they are entirely dependable, and they are not advocated.

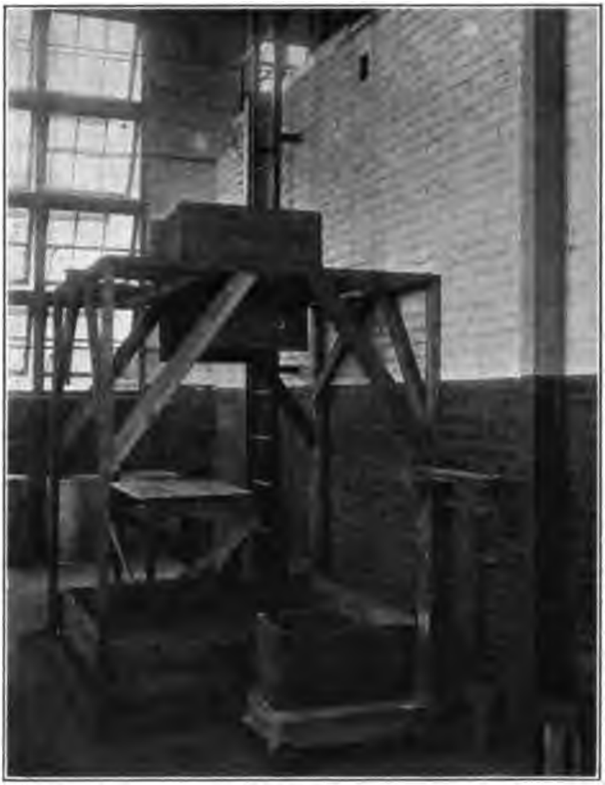
These tests are described in Technical Paper No. 50 of the Bureau of Mines on Metallurgical Coke.

Shatter Test of Coke.

This description is taken from the Technical Paper No. 50, verbatim, except the modification that the sample used should all be over the 2-inch screen.

For a comparative test it seems as applicable to the large oven cokes with each other, as to retort cokes with each other. There is no common basis of comparing cokes from different sources.

"The apparatus for making the test as shown in Fig. 23 consists of a supported box capable of holding 100 pounds of coke, the bottom of the box being 6 feet above a cast-iron plate. The doors on the bottom are so hinged and latched that they will swing freely when opened and will not inpede the fall of the coke. Boards about 8 inches high are placed around the iron plate so that no coke may be lost. With a coke fork a sample of approximately 50 pounds over 2-inch size is placed in the box, no attempt being made to arrange it therein. The entire contents of the box is dropped four times on the iron plate, the small material and the dust being returned each time with the large coke. After the fourth drop the material is screened on a screen of 2-inch mesh; the coke that remains on the screen and what passes through are weighed and the breakage is determined. If the sum of the weights indicates a loss of over 1 per cent. the test is rejected and a new one made."



Shatter Test Apparatus.

Method for the Determination of Apparent Specific Gravity.

Weigh out 8 to 10 pieces of representative dry coke, and completely immerse in water in the special tank for at least 5 minutes. Add enough water to fill the tank exactly to a fixed mark near the top, then take out the coke pieces, draining each into the tank for about 30 seconds. By means of a suitable measuring stick, graduated to read liters and tenths, measure the space from the mark down to the water level. This space is equal to the apparent volume of the coke.

$$\frac{\text{Weight of coke (kilos)}}{\text{Apparent volume (liters)}} = \text{Apparent sp. gr. of coke.}$$

Measuring Stick and Special Tank.

The special tank is conveniently a cylindrical can with vertical sides, about 2 feet high and 1 foot in diameter.

For measuring thrust the stick vertically down the side of the tank inside until the stop rests on the top. Zero on the stick then is level with the mark. Take out the stick and take reading down to the point where it is wet.

Method for the Determination of True Specific Gravity.

Apparatus.—A 100 cubic centimeter measuring flask, whose weight alone, and when filled exactly to the mark with the benzol at the temperature of tests, is known. This temperature must be the same as that of the room at the time of making the tests.

Determination.—Fill the flask nearly half full with benzol, then add 30 grams coke (80 mesh or finer), by means of a glass funnel, in such a way that it will drop directly into the benzol, a little at a time. Agitate, by rotary shaking, to eliminate all air, then fill exactly to the mark with benzol and reweigh.

Let A = weight of flask filled with benzol.

Let B = weight of flask alone.

Let C = weight of flask filled with 30 grams coke and benzol.

Then:

$$\frac{0.3\,(A - B)}{30 + A - C} = \text{True sp. gr. of coke.}$$

Calculation for the Determination of Porosity or Percentage of Cellular Space.

$$\frac{\text{True sp. gr.} - \text{app. sp. gr.}}{\text{True sp. gr.}} = \text{Cellular space.}$$

Method for the Determination of Moisture.

For moisture determinations of either coke or breeze, representative samples, preferably not less than 50 pounds, should be taken and carefully weighed. These samples should then be put in a drying closet, which is kept at a temperature of 115° C. The drying closet should be provided with a means for insuring continuous ventilation. After 8 hours the sample may be taken out and weighed. The loss of weight divided by the original weight of the sample is the percentage of moisture.

Weight Balance.

The weight balance from carbonization can be determined with much less difficulty to a close approximation than that from water gas manufacture. But even in the former it must be remembered that there are inevitable losses of deposited pitch and of gas at the charging and discharging of retorts.

The inherent difficulties of measuring, sampling and testing a water-gas plant for a weight balance are very great, and it does not seem advisable to recommend it.

To determine the weight of gas, take the specific gravity at the same temperature as the meter. Then multiply this specific gravity by the weight of a cubic-foot of air saturated at this temperature, and by the metered volume of gas corrected for barometric and meter pressure only, and subtract the weight of moisture in that volume at the given temperature.

Codes.

The appended codes for reporting tests of carbonizing plants and water-gas-generating apparatus are proposed. The items of the codes are numbered.

FORM FOR REPORTING TEST OF A COAL CARBONIZING PLANT.

1.

1. Plant at
2. Duration of test, to determine

Description of Carbonizing Apparatus.

3. Name and type of retort or oven setting
4. Number of benches in use
5. Number of retorts in use
6. Dimensions of retort or chamber
7. Material used in retorts and settings
8. Days run since retorts were set or rebuilt
9. Condition of retorts at beginning and end of test
10. Average time since scurfing
11. Number and size of standpipes per retort
12. Kind of seal for dippipes
13. Method of charging retorts
14. Method of discharging retorts
15. Name and type of furnace
16. Dimensions of furnace
17. Size and description of grate
18. Primary air heated, temperature
19. Secondary air heated, temperature
20. Method of clinker prevention—Waste gas return, steam, etc.
21. Pounds steam per pound coke
22. Nature of air regulation
23. Kind of draught
24. Horse-power of fans, if used
25. Are waste heat boilers used
26. Heating surface, square feet
27. Method of draught for boilers

Description of Materials.

Gas Coal:

28. Kind of coal and source
29. *Condition*: Weathered, fresh, lumpy, fine, wet, dry
30. *Approximate Analysis*:

	Per cent.	Pounds in coal used
Moisture		
Volatile combustible		
Fixed carbon		
Ash		
Total		

31. SULPHUR:
32. *Ultimate Analysis*:
Hydrogen
Carbon
Oxygen
Nitrogen
Sulphur
Ash

Total
33. B. t. u. per pound

PRODUCERS:
34. Kind and size of fuel
35. Moisture
36. Volatile combustibles
37. Fixed carbon
38. Ash
39. Sulphur
40. B. t. u. per pound
41. Analysis of ash
42. Fusing point of ash
43. Nature of ash and clinker
44. Fuel gas, kind and source
45. Fuel gas, B. t. u. per cubic foot

OPERATION.

46. Average duration of charge
47. Time in retort in continuous system
48. Average weight of charge
49. How is this weight determined
50. Coal carbonized per retort per day
51. Coal carbonized per lineal foot per day
52. Method of weighing total coal
53. Method of weighing total coke
54. How is coke handled
55. Per cent. of retort hours lost for scurfing repairs
56. Fuel gas used per 100 pounds coal
57. Fuel used in furnace per 100 pounds coal
58. B. t. u. in fuel per 100 pounds coal
59. Fuel burned per square foot grate
60. Size of fuel used
61. How is fuel weighed
62. Depth of fuel in producer

63. Producer charging intervals
64. Clinkering intervals
65. Time for clinkering
66. Method of clinkering
67. Per cent. ash discarded
68. Combustible per 100 pounds coal
69. Cleaning intervals for outlet pipes
70. Average temperature outside air
71. Average temperature preheated air, outlet regenerator
72. Average temperature combustion chamber or oven flues
73. Average temperature retort chamber
74. Average temperature retorts
75. Average temperature vertical retorts Top Middle Bottom
76. Average temperature inlet recuperator, waste gas
77. Average temperature outlet recuperator, waste gas
78. Average temperature inlet waste heat boiler
79. Average temperature outlet waste heat boiler
80. Average temperature standpipes
81. Average temperature foul mains Rich main Fuel gas main
82. How often is primary inspected and adjusted
83. How often is secondary inspected and adjusted
84. Air used per cubic foot fuel gas
85. Cubic feet primary mixture per pound fuel
86. Per cent. CO_2 in primary mixture
87. Cubic feet secondary air per pound fuel
88. Per cent. CO_2 in waste gas
89. How is the air measured
90. Pressure under grate
91. Pressure combustion chamber
92. Pressure outlet recuperation
93. Analysis waste gas

	Inlet regenerator	Outlet regenerator
CO_2		
O_2		
CO		

94. Leakage per cent.
95. Average pressure at retort outlet
96. Average pressure in foul mains
97. Average pressure at meter inlet
98. Average pressure of barometer
99. Average temperature at meter inlet

MANUFACTURING RESULTS.

(Computed from Dry Coal.)

100. Gas made by meter cubic feet
101. Type of meter
102. Volume correction factor
103. Gas made corrected to 60° 30 inches barometer and zero pressure at the meter inlet cubic feet
104. Coal carbonized, as charged pounds
105. Coal carbonized, dry pounds
106. Lump coke made, dry pounds
107. Breeze made, dry pounds
108. Total coke made, dry pounds
109. Total coke made, dry per cent.
110. *Approximate Analysis of Coke Produced:*

Moisture Per cent.
Volatile combustibles
Fixed carbon
Ash

111. Sulphur
112. B. t. u. per pound
113. Analysis of ash
114. Fusing point of ash
115. Breeze through ½-inch square openings, per cent.
116. Apparent specific gravity
117. True specific gravity
118. Shatter tests
119. Gas per pound of coal cubic feet
120. Gas per retort per day
121. Average candle-power with burner
122. Average candle-power with Metropolitan No. 2
123. Candle-feet per pound with burner
124. Candle-feet per pound with Metropolitan No. 2
125. Gas for test taken from
126. Frequency of tests
127. Standard used
128. Oil dew point of gas as tested
129. Water dew point of gas as tested
130. Specific gravity of gas
131. Average B. t. u. in gas
132. Thermal feet per pound
133. Analysis of Gas:

	CO_2	Ill.	O_2	CO	H_2	CH_4	N_2
Illuminating							
Fuel							

134. NH_3 in gas at foul main grains in 100 cu. ft.
135. H_2S in gas at foul main grains in 100 cu. ft.
136. H_2S in gas at inlet purifiers grains in 100 cu. ft.
137. Cyanogen in gas at foul main grains in 100 cu. ft.
138. Naphthalene in gas at outlet purifiers grains in 100 cu. ft.
139. Fixed sulphur in gas at outlet purifiers grains in 100 cu. ft.
140. Total ammonia recovered pounds
141. Ammonia made per ton coal pounds
142. Total tar made, dry gallons
143. Tar made per ton coal, dry gallons
144. Free carbon in tar per cent.
145. Naphthalene in tar per cent.
146. Distillation of tar, degrees Centigrade:

Moisture to 110°	per cent.	to 270°	per cent.
to 170°	per cent.	to 300°	per cent.
to 235°	per cent.	Residue	per cent.

147. Water evaporated in waste heat boiler pounds
148. Water evaporated from and at 212° pounds
149. Water evaporated per net ton carbonized, from and at 212° pounds
150. Boiler horse-power developed
151. Average steam pressure of waste heat boiler
152. WEIGHT BALANCE:

1 Ton Coal.			*Products.*	
Moisture	%	lbs.	Water:	
Vol. comb.	%	lbs.	Aqueous drips	lbs.
Fixed carbon	%	lbs.	Absorbed in purifiers	lbs.
Ash	%	lbs.	in tar	lbs.
			in gas	lbs.
		2,000 lbs.		
Accounted for		lbs.		
			Gas, dry	lbs.
			Tar, dry	lbs.
			Coke, dry	lbs.
			Total	lbs.
			Less extraneous air	lbs.
			Accounted for	lbs.

FORM FOR REPORTING TEST OF WATER GAS GENERATORS.

CARBURETED WATER GAS GENERATING SETS

1. Plant at
2. Duration of test
3. To determine

DESCRIPTION OF GENERATING APPARATUS.

4. Name of set
5. Outside diameter of generator   carbureter   superheater
6. Inside diameter of generator   carbureter   superheater
7. Lining, thickness of brick and asbestos
8. Grate area
9. Average depth of fuel carried
10. Length of fixing brick columns   carbureter   superheater
11. Number of fixing brick
12. Kind of brick
13. Spacing of brick
14. Number of cleaning doors on generator
15. Size of cleaning doors on generator
16. Kind of grate, fixed or shaking, per cent. of air space
17. Number hours run since recheckering carbureter
18. Distance from oil spray to checker bricks
19. Kind of oil spray
20. Condition of generators at beginning and end of test

DESCRIPTION OF MATERIALS.

A. *Fuel*:

21. Kind
22. Method of weighing
23. Size
24. Used hot or cold
25. How sampled
26. Approximate analysis: Moisture
    Volatile combustible   Fixed carbon
    Ash   Sulphur
27. B. t. u. per pound
28. Analysis of ash
29. Fusing point of ash

B. 30. Enriching oil:

31. Shipper
32. Field
33. Specific gravity
34. Analysis, per cent. to degrees Fahrenheit:
    300°   400°   500°   600°   700°   over 700°

C. 35. Steam: Live or exhaust How measured
36. Saturated Superheated to
37. Pressure at regulating valve
D. 38. Air: Type of blower used
39. Revolutions and capacity
40. Size generator blast connection
41. Size carbureter blast connection
42. Type of meter used

OPERATION.

Make:

43. Gas made by meter
44. Type of meter
45. When tested
46. Average temperature at meter inlet
47. Average pressure at meter inlet
48. Average barometric pressure
49. Volume correction factor
50. Total gas made corrected to 60° 30 inches barometer and zero pressure at meter inlet
51. Gas made per run
52. Gas made per hour
53. Gas made per hour deducting cleaning time
54. Gas made per set per day
55. Gas made per set per day per square foot grate area

Fuel:

56. Total fuel used as fired
57. Fuel per M as fired
58. Fuel per M dry
59. Fixed carbon per M from analysis
60. Ash and clinker removed during cleans, and discarded to dump
61. Dry ash, etc.
62. Theoretical ash per M from analysis
63. Combustible per M

Oil Results:

64. Oil used by meter
65. Oil used by tank
66. Oil used by tank corrected to temperature of 60°
67. Oil per M, corrected

Gas Tests:

68. Candle-power of gas with burner
69. Candle-power of gas with Metropolitan No. 2 burner
70. Candles per gallon with burner

71. Candles per gallon with Metropolitan No. 2 burner
72. Gas for test taken from
73. Frequency of tests
74. Standard used
75. Oil dew point of gas as tested
76. Water dew point of gas as tested
77. Calorific value of gas at
78. Frequency of tests
79. Kind of calorimeter used
80. B. t. u. per gallon of oil
81. Specific gravity of gas
82. Per cent. CO_2 in finished gas
83. How frequently determined

Blow and Run:

84. Length of blow after clean
85. Nominal length of blow
86. Average actual length of blow
87. Length of purge with blast
88. Generator air per minute
89. Average carbureter air per minute
90. Generator air per M
91. Carbureter air per M
92. Total air per M
93. Average blast pressure under grate
94. Blowing capacity available
95. Nominal length of run
96. Actual length of run
97. Coaling periods
98. Cleaning periods
99. Total time for cleanings
100. Method of splitting runs
101. Pounds of steam per M

Temperatures:

102. Carbureter base
103. Superheater base
104. Superheater top
105. Outlet wash-box
106. Outlet exhauster
107. Inlet condenser
108. Outlet condenser
109. Inlet tar extractor
110. Inlet purifier
111. Outlet purifier

112. Outlet station meter
113. Atmosphere
114. Air at blast meter
115. Oil in tank
116. Oil entering set
117. Analyses of blast and illuminating gases:

	Illuminating	Blast
CO_2		
O_2		
Illuminants		
CO		
CH_4		
H_2		
N_2		

118. Water gas tar made
119. Distillation of tar, degrees Centigrade:

Moisture	to 110°	per cent.	to 270°	per cent.
	to 170°	per cent.	to 300°	per cent.
	to 235°	per cent.	Residue	per cent.

120. Water gas tar, specific gravity
121. Water gas tar dry, per cent. by weight of oil used

Dr. J. F. Wing, *Chairman,*
R. N. Davis,
O. B. Evans,
J. H. Taussig,
V. von Starzenski.

Dr. Wing (Continuing): This report is now referred to the Institute for criticism and further instructions.

The Chairman: Gentlemen, this is a very important report, and the Committee requests a very thorough and full discussion. We have one written discussion which I will ask the Secretary to read.

Mr. H. v. Vittinghoff (Boston): (Written discussion communicated.) The gas fraternity undoubtedly deeply appreciates the work done by the members of the Committee on Standard Tests in taking the initial, and most important, step towards acquiring the information which is sorely needed by us to determine matters of operating efficiency and manufacturing plant extensions. Members of our profession frequently claim to decide such matters on "a broadly economic basis" or are smugly satisfied to rest their decisions on "past experiences" or the "other fellow's say-so." All three reasons are, of course, perfectly good if only they were always based upon accurate observations. The code proposed by the Committee tends towards this ideal, but it does not seem to me that it is sufficiently explicit nor does it go into enough detail to allow the members of the American Gas Institute to dissolve the Committee and relieve the members of its labors.

For instance, the method to be followed in testing a boiler as prescribed by the code of the American Society of Mechanical Engineers* is perhaps comparable to the code now before us. Even a cursory examination will show that it is most comprehensive and detailed and leaves little to the interpretation of those who apply it. Yet the testing of a coal gas or water gas plant is an undertaking much greater in its scope, involving many more factors and vastly more complicated than the testing of any boiler plant of equivalent size or value.

It is not the intention of the writer to attempt to outline the manner in which the work of the Committee should be carried on, but on the assumption and in the hope that the Committee will remain in active service the following comments (which undoubtedly will be added to by other members) may be of interest to the members of the Committee.

On page 422 attention is drawn to the fact that the scheme outlined does not provide for reporting costs of labor and repairs. While this is no doubt justified I believe some reference should be made to the number of men employed in operating the plant exclusive of those needed for making the observations during the test.

Throughout the recommendations references are made to previous reports of committees of the American Gas Institute, but I believe that in a work so important as the proposed code the methods to be followed in sampling and testing for candle-power and heat value should be outlined in sufficient completeness to avoid misunderstandings. I also think that the American Gas Institute should not hesitate to specify definitely the approved types of testing devices which may be used.

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* (See Report of Power Test Committee, 1915, American Society of Mechanical Engineers.)

Referring to the proposed length of test period it might be well to add the precaution that in making any alterations in operating conditions during the test great caution should be used when changing more than one condition at a time as otherwise it will be impossible to analyze the results.

I cannot agree with the Committee that it is permissible to use coal from various sources during a test unless facilities are available to maintain throughout such test an absolutely uniform mixture.

It is, of course, perfectly true that in order to reach a guarantee manufacturers of apparatus have frequently resorted to exceeding the safety limit as far as temperatures are concerned and I believe that in making a guarantee test definite maximum temperatures at various points in the bench should be agreed upon before starting the test.

The recommendation given on the bottom of page 426 that coke be forked and then thrown on a ½-inch screen in order to determine the percentage of breeze does not seem to me absolutely fair under all conditions unless a narrow-tined fork is used, since the ordinary coke fork will leave a residue containing pieces of coke much larger than those which would safely pass over a ½-inch screen.

I believe it would be interesting to know not only the specific gravity of the coke, but also its specific volume. The so-called "apparent specific gravity of coke" appears to me to be an entirely arbitrary standard. It depends first of all on the period of time during which the coke is drained over the tank. Secondly, it seems to me to be a factor of the manufacturing process which may either result in pores in the coke which are ruptured and therefore open to the saturating water or are closed entirely which would result in a low apparent specific gravity. The true specific gravity of finely powdered coke does not seem to me of any practical importance. What we are all really interested in is the weight per cubic foot of coke or the number of cubic feet per ton.

I should think that there would be no great difficulty in determining upon a fair definition for specific volume of the coke, providing a representative sample of sufficient size were taken for the determination.

I was much gratified to note the recommended method for determination of moisture. It has always appeared to me that the laboratory method of taking a gram or so of coke or coal and using that to determine the moisture contents of several thousand tons of the material is more or less absurd and subject to very large errors.

Referring to item No. 9 on page 432 it may be well to elaborate the report desired under condition of retorts. If the question is left as stated 99.9 per cent. of all answers will probably consist of the single word "good" or "excellent." Item 11 might read "Number and size of standpipes per retort or retorts per standpipe."

It seems to me very difficult to answer question 56 and some method for arriving at an answer should be definitely agreed upon.

Referring to temperature measurements it may be well to definitely specify just what apparatus should be used for making these determinations.

I note that the hydrogen sulphide in gas at the foul main is to be determined and I would propose extending the requirements of the code to the determination of ammonia.

If the test covers a considerable period of time a careful record should be kept of the amount of "time out" for scurfing, etc., and the results converted into performance of the plant "ex-scurfing."

The above comments, or those made by other members, may or may not be agreed to by the Committee; they may be accepted or rejected by the American Gas Institute. That is a matter of comparatively little importance. The vital point is that the code finally adopted to govern the conduct of tests of gas manufacturing plants should be comprehensive, explicit and should include every possible precaution against misrepresentation of results either through personal bias or misunderstanding of the requirements. No attempt should be made to control the results aimed for, but in considering whatever results may be obtained we should be absolutely certain that we are all talking the same language.

MR. PAUL DOTY (St. Paul, Minn.): I am one of the guilty ones, Mr. Chairman. The Institute is to be congratulated upon this advanced step that is being taken in even preparing forms. One naturally speaks from experience, and I remember a good many years ago having to conduct a test of a water gas machine in order to determine for the company I represented whether the guarantees of the manufacturers were being fulfilled. Having no official report of the American Gas Institute, or its predecessor associations, one naturally turned to other sources of information. I remember very distinctly going to the Boiler Code of the American Society of Mechanical Engineers, and ascertaining just what data they included in their forms, and the result they had attempted to secure. Now, this is true of these forms—they are complete and worthy of record. One interesting thing in connection with the report is the recommendation that at least a week's test be provided for a water-gas machine.

I remember the test we made extended over a period of 24 hours, the guaranty of the manufacturers covering a 24-hour period; and it was a pretty strenuous 24 hours of continuous observation. To-day, with the official sanction of society for the 8-hour day, I imagine many operators would be needed to conduct a week's test of a water-gas machine, and perhaps many more have a month's test of a coal-gas plant.

It goes to show that progress is being made, and undoubtedly a week's test of a water-gas machine would give a truer test of what the machine is capable of doing. I have no specific comments to make on the text of the paper. It is complete, and the written discussion of the gentleman who has preceded me enables the Institute to have on record a fairly good understanding of what is required.

If the manufacturers agree to have a test conducted by the owners of the property, in accordance with these forms, much good will be accomplished. The difficulty in the interpretation of contracts is the misunderstanding of the minds. The contract means the meeting of minds, if the meeting of minds can be made on a proper basis there is no question of dispute left.

MR. V. VON STARZENSKI (Schenectady, N. Y.): Reference has been made to the omission of labor in the report. That matter was discussed in the Committee meeting, and it was considered that this report is a report of performance of the plant, and that the labor is not directly connected with that. In other words, in any contract the matter of labor would have to be taken up, considering the particular conditions under which the plant was to be operated. For instance, there might be 12-hour shifts, 10-hour shifts, or 8-hour shifts. This depends on local conditions and is a matter of management which really does not enter into the performance of the plant.

There is another point, that is, the shatter test. The test given is from the paper of the Bureau of Mines, except that the test should be over a 2-inch screen. The Committee goes on to say: "There is no common basis of comparing cokes from different sources."

It seems to me that if relatively narrow limits were used in size of coke used for test, and the screen mesh for shattered coke were in direct proportion, or a fraction of the original screen, that some definite relation could be obtained. In other words, a uniform sized coke might be selected that would pass over a 4-inch screen. The shattered coke could then be passed over a screen one-fourth as large, or a 1-inch mesh.

To compare a larger coke, take lumps, for instance, that would just pass over an 8-inch screen, then shatter this coke and pass it over a 2-inch screen. The amount in this case passing through a 2-inch screen would be comparable to the amount passing through a 1-inch screen in the first instance.

MR. PAUL DOTY: There is one question, Mr. Chairman, that is, if the Committee intends to note the condition of the water-gas machine at the time of starting and then when the test is finished, it seems to me important that some attention should be paid to the condition in which the test is finished. The depth of the fire at starting, and at the finish, should be carefully noted, for, with the capacity of modern machines, there is leeway, and the same is true with the carbureters and the superheater.

I would like to ask whether the Committee had that in mind.

PROF. A. H. WHITE (Ann Arbor, Mich.): The report of the Committee is evidently intended to cover the tests of a plant under actual operating conditions, to determine whether it has complied with the guarantee. If the test is to determine the value of a change in operation, should not the test cover a much shorter period of time? We all know that in the operation of a coal gas plant, conditions vary from minute to minute, and if it is a question of research work, then we must watch every variable and strive to hold everything constant but the one variable. It is absolutely impossible to do that over a long period of time. In the work we have conducted at our experiment station for the Michigan Gas Association, we have worked on a single charge put into the retort, and we have watched every variable condition as far as possible. Even there it is impossible to determine every change of every variable. Necessarily in a month's or week's test the result is the average of good and bad operating conditions which you have during that period.

There was one minor point which indicates an overlapping of committee functions. There is a Committee on Gas Chemists' Handbook, which has not yet reported, but which has included in its report a method for true and apparent specific gravity of coke and the shatter test. The methods of the two committees are the same for the shatter test, but they differ in the case of specific gravity. It would be advisable to have these reports harmonized before publication.

MR. J. M. SPITZGLASS (Chicago): Mr. Chairman, I wish to discuss this report, although I was not here when it was read, but it seems to me that those who are called upon to run tests will appreciate having this form laid out for them. Sometimes we think we have reported everything necessary in a given test, and yet a year later we find that just what we wanted is missing in the report; and I think it is very well to have such a form as we have here, prepared for our use.

We do not necessarily have to watch all the items which are given in the report, but we know which ones we want, and can pick them out. We are reminded of all the conditions which are desirable to be known.

There are one or two things I would like to call attention to. I believe the Committee should emphasize strongly the necessity of reporting results of tests, on the amount corrected to standard conditions of 30 and 60. Last year I visited a plant, in a location of one mile and a half nearer to the sky than we are here. The manager of the plant told me they were running on 3 gallons of oil and 28 pounds of coke, and it looked good to me. Then I asked him if this was on corrected gas, and he said, "Yes, it is on the corrected amount."

Later I asked about the candle-power of the gas, and it appeared that while the candle-power was related to a standard of 30 and 60 the actual volume of the gas was corrected for temperature only. So that in fact the altitude had added about 30 per cent. to the efficiency of the coke and the oil. We read sometimes such results which make us wonder how people are doing it, while the fact is that the cubic foot of gas is not the same. It is very important therefore that the results should be reported on a standard cubic foot, which means a definite weight of gas in any location.

Another point is given in the report that the correction should be made to zero at the meter. I thought it was general to correct to 5 inches of water at the meter, but I know of cases where they do not correct even for 8 inches of water pressure at the meter.

Now, I heard a gentleman mention that the determination of true specific gravity of coal is given in another report. With relation to this I want to ask Dr. Wing to explain more definitely the formula for determining the specific gravity, as there is given a coefficient in the numerator and there is nothing said as to whether that is for any amount of coke used, or for the amount of 30 grams only.

On page 431, in determining the weight of the gas, the report says: "Take the specific gravity at the same temperature as the meter; then multiply this specific gravity by the weight of a cubic foot of air saturated at this temperature, and by the metered volume of gas corrected for barometric and meter pressure only."

That would leave the weight of a cubic foot of gas at the meter temperature. That would mean more pounds of gas than we actually have because it would include the moisture of the meter temperature which is usually above 60° F. I would like to ask Dr. Wing to explain this point.

On page 437, giving a description of the generating apparatus, I would suggest a couple of items more to add: The number of courses of checkerbricks and the number of bricks in each course.

On page 438, where the type of the blower is given, it should also give the pressure for which the blower is designed.

The oil result shown is "Oil used by meter" and "Oil used by tank." Then "Oil used by tank" corrected for temperature. We know the meter is not as accurate as the tank measurement in the long run. But for reporting daily results the tank measurements may be off a great deal, and the method we usually follow is to report the results, as the meters show and after a number of days to correct these results by the tank measurements, thus making the daily figures proportional to the meter readings and not to tank readings.

THE CHAIRMAN: Anybody else wish to discuss the paper? We will ask Dr. Wing to close the discussion.

DR. J. F. WING (Everett, Mass.): One of the points that Mr. Vittinghoff makes is that he wishes to have included in the report explicit directions for making the tests. The American Society of Mechanical Engineers furnishes full directions for making tests of pumps and boilers and other mechanical apparatus. A similar undertaking for the varied types of apparatus and diverse conditions of operating in gas seemed pretty large for this Committee. If they made conveyors and other machinery about the gas works as nearly alike as pumps are, we would attempt it.

We say in the report that many things must be done according to the conditions at a plant, which are not applicable in another plant, and we let it go at that. The Committee has never seen all the plants and we feel sure we could not furnish methods to apply to all conditions.

There is another paragraph in the report which provides that the method of making tests shall be agreed upon by the buyer and the contractor, where it is a question of a guarantee.

The guiding principle is that everything should be weighed and measured correctly.

Mr. Starzenski notes that no provision is made for reporting the number of men employed. Generally this is reported rather loosely by anybody running a plant. He defines, possibly, the use of his men in a way which might be determined differently by others. That number of men can be determined so differently, and it is so much a question of management, and not a question of testing, that we did not put it in the report.

He also spoke of item No. 9, where it calls for the condition of the retort before and at the end of the test, presumably. That is something which could not be written out in one line as provided for in the Code. It would have to be amplified, and it seems to me not to require any greater definition.

The question calling for the determination of ammonia and hydraulic mains is reasonable, and should be put in anyway.

Mr. Doty was uncertain about the condition of the apparatus in water gas plant at the start and at the finish of the test. We note in the text of the report that these tests, especially for guaranty tests, should be undertaken after the apparatus is in normal running condition, and if a water gas machine runs for a week, the generator is filled a good many times, and there is only 6 or 8 feet of fuel in it, and there would not be a very wide error. This item will be inserted.

In this case the generator's physical condition would have to be noted and described. But it is not intended, according to our judgment, to start a test like that from a cold machine. It is as if you started a boiler test with boiler grate bars, and end the test with the boiler grate bars. The conditions of the superheater and the carbureter are noted in the test when one can observe them.

Mr. Starzenski brought up again this shatter test of coke which we have discussed among ourselves before. We had seemed to run against a blank wall there in comparing the hardness or toughness of oven coke with retort coke, 4 inches through, and this proposition of starting with a standard size to shatter; by taking oven coke between 3 and 5 inches, and shattering that, you must start with a coke which has been broken once, and the friable proportions separated. We really cannot prepare a suitable way for a satisfactory test.

Professor White in his remarks noted the difficulty in keeping conditions constant, where you are attempting to run according to certain pre-determined conditions, and anybody who has attacked this proposition knows how true that is. The only escape from this difficulty is to have a test from which you want reliable results continue over a period of a week or a month, and to have the variable data taken hourly, or more frequently, and trust to combining a fair average of all these varying conditions.

The duplication of tests, appearing here and in the report of the Committee on Chemical Tests, may be fortunate or otherwise. We will leave that to the Committee on Publication to be the umpire. Such as are physical tests would appear to belong to this report.

Mr. Spitzglass has remarked that we corrected the meter readings to zero pressure on the meter at 30 inches barometer. He mentions 5 inches as common practice for meter pressure. Other people will consider 3 inches common practice, and we can only have a common basis for all these by selecting one ourselves, and perhaps arbitrarily, and we take zero pressure at the meter for these pressure corrections.

He speaks of the method or formula for determining the weight of the gas in coal gas, and he does point out that the weight of the gas determined by this method, by comparing it with the specific gravity of air contains a lot of water vapor, and the water is not otherwise accounted for in this scheme. But I think through this hasty study of it, that the net weight of gas—say it contains 1½ per cent. of moisture—is not taken much too high, as it is compared with the weight of atmospheric air which also contains 1½ per cent. of moisture. It does make some difference in the weight of the gas, and it does leave that moisture unaccounted for in the water proper. The proper change will be made in the directions for determining the actual weight.

We note ourselves that some improvements can be made in the typographical arrangements of these codes. Some of them are not very plain and some could be changed in their sequence. That will be done.

The question of the formula for the true specific gravity of coke, on page 430 of the report, was made very laconic here. and without any explanation. It might have been more easily intelligible had we used water and compared the weight of the coke with the water. But in this case we are comparing a certain weight of coke—30 grams—which would have the gravity of 30 centimeters of water. Now, as the flask contains 100 cubic centimeters, we have 30 per cent. of the weight of the benzol in the numerator. And the denominator means the weight for the volume of coke, if compared with an equal weight of water in the numerator. In case benzol is used, the combined factors in the denominator mean the weight of the volume of benzol displaced by coke. It really makes no difference what fluid you use.

I might add that this report does not enable us to evaluate the results you will get by one system of carbonizing on comparing it with another. We still have something to learn of the physical properties of the firebrick and the proper temperatures for carbonizing coal. It is a step in advance to have a report on all the conditions that are valuable.

The Chairman: I might say that the Manufacturing Section will be glad to have any written discussion that any member wishes to submit on this report, also on Mr. Hall's paper "A New Oil Gas Plant." Dr. Wing has closed the oral discussion, but that does not preclude the submission to the Secretary of written discussions.

Will some one please move that the report be received and accepted?

Mr. Paul Doty: I so move, Mr. President.

(Motion seconded and carried.)

The Chairman: Gentlemen, this concludes the meeting of the Manufacturers' Section. If there is no further business to come before that Section, a motion to adjourn is in order.

Mr. Doty: I make such a motion, Mr. Chairman, that we adjourn.

(Motion seconded and carried.)

Whereupon the Manufacturing Section adjourned.

ACCOUNTING SECTION.

Second Session, Wednesday A. M. October 18.

MR. J. P. CROWLEY, *Vice-President,* presiding.

MR. H. HARMAN, *Secretary.*

THE CHAIRMAN: The meeting will please come to order.

The first paper on the program this morning is "Cost Records on Appliance Installations," by H. B. Lohmeyer (Baltimore, Md.). (Mr. Lohmeyer read his paper, as follows:)

COST RECORDS ON APPLIANCE INSTALLATIONS.

In recent years there has been considerable change in the attitude of gas companies, in regard to the merchandising end of their business. Formerly the sale of gas consuming and related merchandise was looked upon entirely as an incident to the sale of gas and was considered a New Business proposition and not a direct revenue—producing branch of the business. Under this view of the situation it was customary to charge all Selling Expenses, salaries, commissions, etc., to New Business Expense, instead of against the gross profit on merchandise sold.

With the growth of the business comes the realization that this branch of the business can and should be self-sustaining and that placing it on its own merits, does not retard nor interfere with the purposes of the New Business Department, *i. e.,* the increased consumption of gas.

Having reached the point where profits as well as increased gas consumption are deemed desirable, the question of selling price looms up as even more important than when the gas business carried part of the load. Before fixing a selling price, one is confronted with the problem of analyzing the component parts thereof. These may be briefly stated as:

1. Cost of Goods Sold.
2. Cost of Installation.
3. Selling Expenses.
4. General Expenses.
5. Profit.

It is the purpose of this paper to discuss more particularly the second item "Cost of Installation" but brief comment on the other phases of a selling price may not be amiss.

1.—COST OF GOODS SOLD.

This consists of the following items:

(A) *Net invoice cost* from producer or dealer, which is charged to the Stock Account and enters into the cost when the sales are made.

(B) *Freight and Expressage.*—Usual practice would dictate that these items should be pro-rated over the number of units in each shipment to which a freight bill applies, as Freight and Expressage is, strictly speaking, a part of the purchase price, f. o. b. consignee's city. However, for practical purposes, the same final result is obtained by charging all such items to one account.

(C) *Cash Discount.*—Why follow the usual method of deducting cash discount from the invoice, and consider the price, less such discount, as the unit cost? Cash Discount is credited to a "Cash Discount" account and together with the foregoing account, "Freight Expressage," is closed into "Storeroom Expense." The procedure may be criticized as not being good accounting, in that the two items are entirely separate and neither is a part of the Expense of operating a Storeroom. While such a criticism is justifiable; when it has been found that in the total transactions the Cash Discounts earned about equal the charges for Freight and Expressage, and in reality only a small debit or credit balance finds its way into the Storeroom Expenses; the same practical result has been accomplished with considerably less clerical work.

(D) *Breakage and Damage in Stock.*—This item is a true part of storeroom expense and should be so carried, but a separate record should be kept as a check on carelessness of the storeroom force.

(E) *Storeroom Expense.*—To this is charged all salaries, wages and expenses incurred in handling and storing material, to which is added or deducted the small debit or credit balance of "Cash Discount" and "Freight and Expressage" as outlined above, and the whole distributed on a percentage basis over the merchandise delivered from stock each month, for each sales unit.

(F) *Defective Merchandise Replaced.*—In every business, more or less goods are returned by customers with complaints of defective material. If the complaint is allowed, and the goods replaced, the cost of the defective goods fall in one of three classes:

a—Defect in original merchandise,
b—Defect in installation,
c—Policy replacements of merchandise.

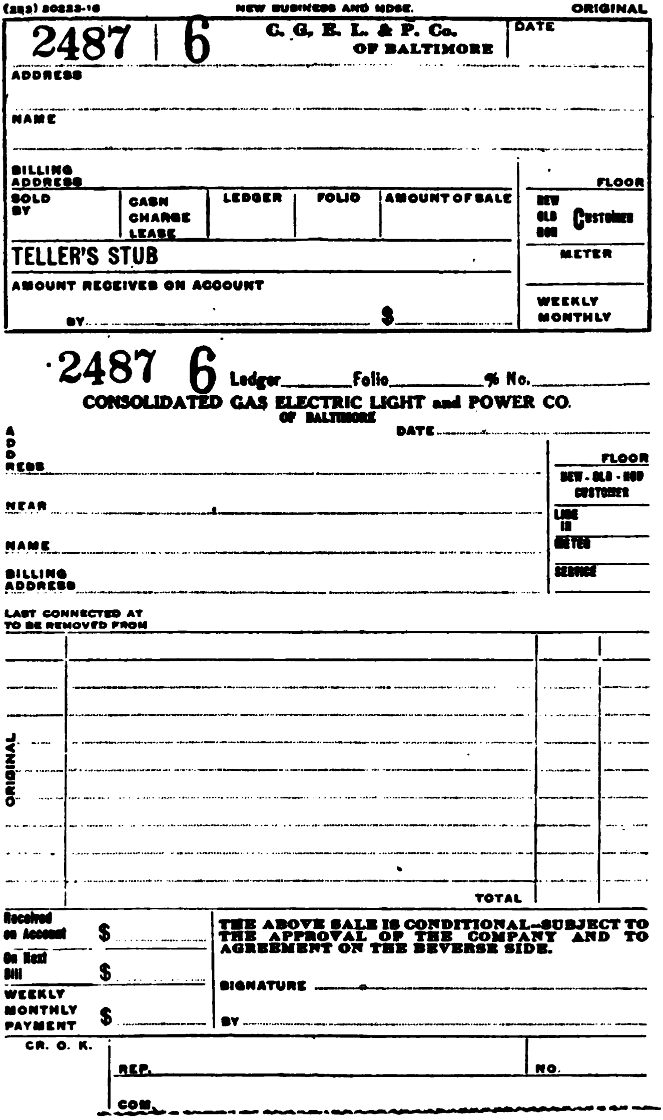
Only those which fall in the first class should be included under "Defective Merchandise Replaced" as a part of the "Cost of Goods Sold." This class of refunds does not enter into the cost to any appreciable extent as they are usually offset by contra refunds from the manufacturers. The other two classes will be explained later under their proper captions.

The foregoing items cover the elements entering into the bare cost of goods sold and in the case of goods not requiring installation is also the total cost exclusive of the various selling and general overhead expenses.

2.—COST OF INSTALLATION.

This includes all items having to do with placing the merchandise on the customers' premises, properly connected to the gas service, ready for use, and may be divided into:

(*a*) Installation Materials, including pipe, fittings, etc.
(*b*) Labor, including only direct labor specifically chargeable to each installation.
(*c*) Transportation, covering use of automobiles and wagons directly chargeable to each installation.
(*d*) Miscellaneous Expenses, including carfares, telephone calls, a proportion of "Storeroom Expenses" based on the Installation Material used and a proportion of "Tool Expense" based on the direct labor, chargeable to each job, and other direct incidental expenses.



(253) 20223-16 NEW BUSINESS AND MDSE. ORIGINAL

2487 | 6 C. G. E. L. & P. Co. OF BALTIMORE

DATE

ADDRESS

NAME

BILLING ADDRESS

FLOOR

SOLD BY

CASH CHARGE LEASE

LEDGER

FOLIO

AMOUNT OF SALE

NEW OLD MOD CUSTOMER

TELLER'S STUB

METER

AMOUNT RECEIVED ON ACCOUNT

BY $

WEEKLY MONTHLY

2487 6 Ledger Folio % No.

CONSOLIDATED GAS ELECTRIC LIGHT and POWER CO.
OF BALTIMORE

DATE

ADDRESS

FLOOR

NEW - OLD - MOD CUSTOMER

NEAR

LINE IN

NAME

METER

BILLING ADDRESS

SERVICE

LAST CONNECTED AT
TO BE REMOVED FROM

ORIGINAL

TOTAL

Received on Account $

On Next Bill $

WEEKLY MONTHLY PAYMENT $

THE ABOVE SALE IS CONDITIONAL—SUBJECT TO THE APPROVAL OF THE COMPANY AND TO AGREEMENT ON THE REVERSE SIDE.

SIGNATURE

BY

CR. O. K.

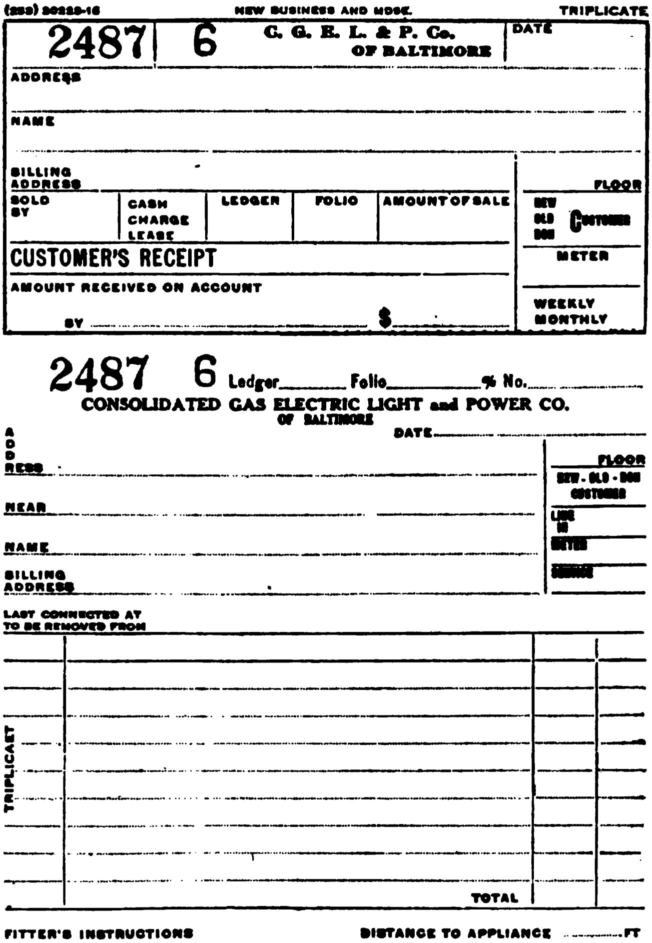
REP.

NO.

COM.

FORM 1.—Original.

(*e*) Supervision: This includes the salaries and expenses of Inspectors and Superintendents, clerks, office expenses, and other items not directly chargeable to any specific installation. This item is pro-rated each month on the basis of the total direct cost of each installation.



(333) 30229-16 NEW BUSINESS AND MDSE. TRIPLICATE

2487 6 C. G. E. L. & P. Co. OF BALTIMORE

DATE

ADDRESS

NAME

BILLING ADDRESS

FLOOR

SOLD BY	CASH CHARGE LEASE	LEDGER	FOLIO	AMOUNT OF SALE

NEW OLD DOM CUSTOMER

CUSTOMER'S RECEIPT

METER

AMOUNT RECEIVED ON ACCOUNT

BY $

WEEKLY MONTHLY

2487 6 Ledger Folio % No.

CONSOLIDATED GAS ELECTRIC LIGHT and POWER CO.
OF BALTIMORE

DATE

ADDRESS

FLOOR

NEW - OLD - DOM CUSTOMER

NEAR

LINE IN

NAME

METER

BILLING ADDRESS

SERVICE

LAST CONNECTED AT
TO BE REMOVED FROM

TRIPLICATE

TOTAL

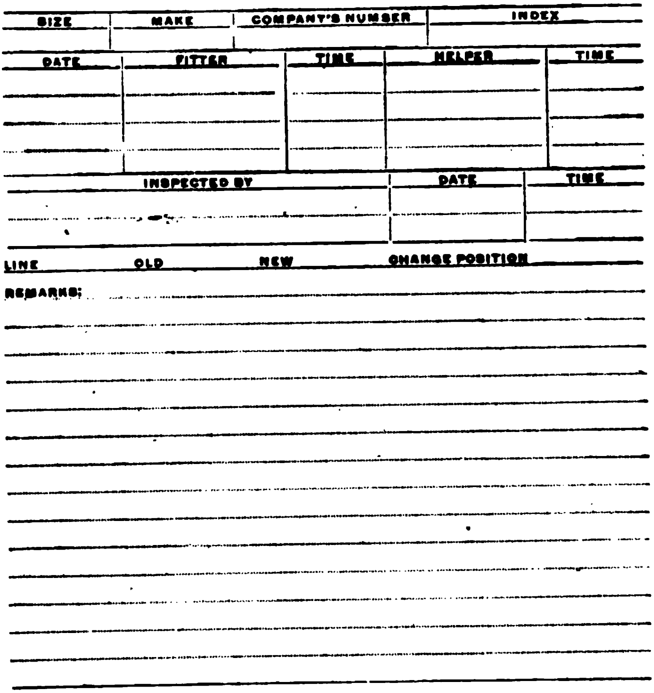
FITTER'S INSTRUCTIONS

DISTANCE TO APPLIANCE FT

FORM 1a.—Triplicate.

These five items cover the entire "Cost of Installation" and are compiled by the following system:

As the installation originates in the sale of an appliance a few words on this may not be amiss, outlining briefly the sales orders.



SIZE	MAKE	COMPANY'S NUMBER	INDEX

DATE	FITTER	TIME	HELPER	TIME

INSPECTED BY	DATE	TIME

LINE ____ OLD ____ NEW ____ CHANGE POSITION ____

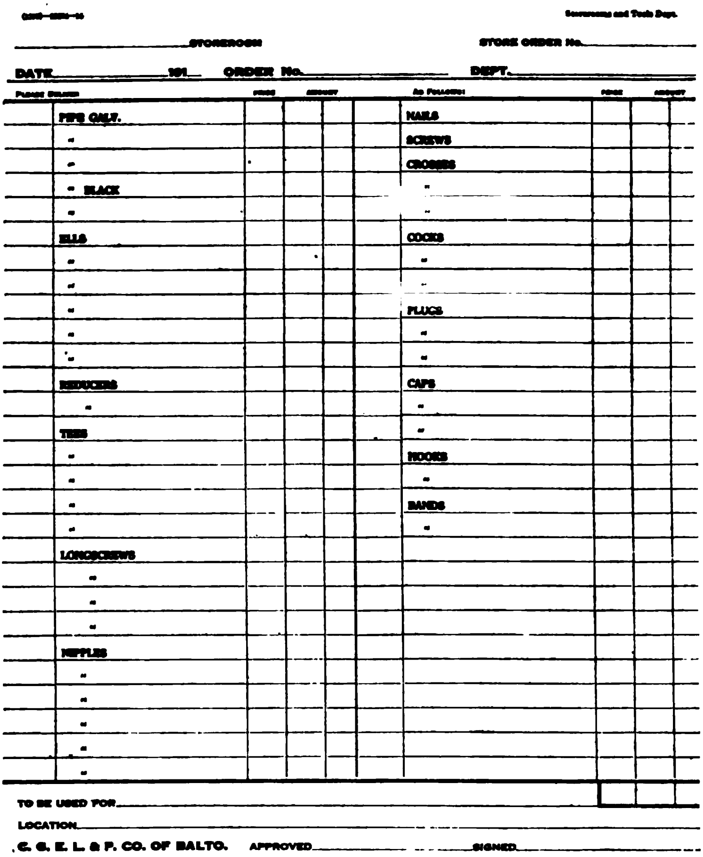
REMARKS:

FORM 1b.—Reverse of Duplicate (Workman's Report).

Forms 1, 1*a* and 1*b* illustrate the sales orders used in our company. These orders are made in triplicate and are made up in books of fifty sets each, the original becomes the office record, the triplicate the Installation Department tracer and the duplicate the workman's copy, the reverse of which (form 1*b*) showing his report.

Upon receipt of an order in the Installation Department, the necessary pipe, fittings and appliance are withdrawn from stock for delivery to the address. The appliance is charged to the "Cost of Merchandise Sold" and the pipe and fittings are charged under "Installation Work—Material" to the job or ticket number on which it is used.

Delivery is accomplished by using triplicate copy of store order (form 2) as "Delivery Sheet" and material used is charged through forms 2 and 3.



Storerooms and Tools Dept.

______ STOREROOM   STORE ORDER No. ______

DATE ______ 191__ ORDER No. ______ DEPT. ______

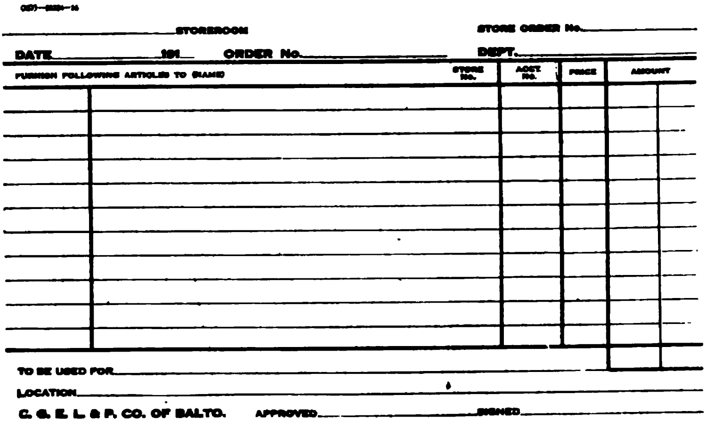
Please Deliver		Price	Amount			As Follows:	Price	Amount	
	PIPE GALV.					NAILS			
	"					SCREWS			
	"					CROSSES			
	" BLACK					"			
	"					"			
	ELLS					COCKS			
	"					"			
	"					"			
	"					PLUGS			
	"					"			
	"					"			
	REDUCERS					CAPS			
	"					"			
	TEES					"			
	"					HOOKS			
	"					"			
	"					BANDS			
	"					"			
	LONGSCREWS								
	"								
	"								
	"								
	NIPPLES								
	"								
	"								
	"								
	"								
	"								

TO BE USED FOR ______

LOCATION ______

C. G. E. L. & P. CO. OF BALTO. APPROVED ______ SIGNED ______

FORM 2.



STOREROOM ____________

STORE ORDER No. ____________

DATE ____________ 191__ ORDER No. ____________ DEPT. ____________

FURNISH FOLLOWING ARTICLES TO (NAME)	STORE No.	ACCT. No.	PRICE	AMOUNT

TO BE USED FOR ____________

LOCATION ____________

C. G. E. L. & P. CO. OF BALTO. APPROVED ____________ SIGNED ____________

FORM 3.

These forms are identical in nature in that they both represent withdrawals from stock, being material drawn direct from storeroom and for pipe and fittings used by the workmen at the time of installation.

Direct Labor and Transportation are recorded through the use of the workman's "Time Sheets" (forms 4 and 5).

These items are charged under "Installation Work—Labor" to the proper ticket number.

Miscellaneous Expenses are charged to the proper job on "Petty Cash Vouchers" (form 6) "Car Ticket Receipts" (form 7) and "Telephone Tickets" (form 8).

"Storeroom Expense" and "Tool Expense" as previously stated are pro-rated on the basis of Installation Material and Direct Labor, respectively. It should be noted, however, that for convenience the pro-rating is done on a fixed percentage basis, thus leaving a slight balance in these expense accounts. This fixed percentage may be changed from month to month should conditions prove them to be too high or too low.

This completes the forms used in recording the original data relative to the costs of installation.

1697—30310—16 Elec. Distribution Dept.

C. G. E L. & P. Co. TIME REPORT OF ____________ DEPT. ________ DATE ____________ 191 ____

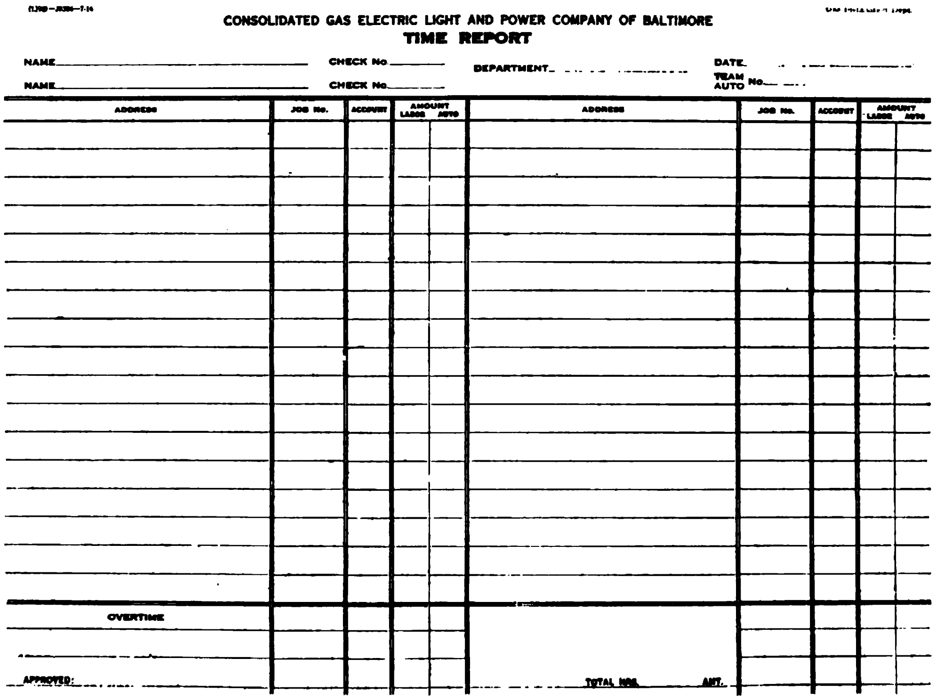
NAME ____________ TOTAL HRS. ________ AMT. ________

NAME ____________ TOTAL HRS. ________ AMT ________

				LABOR				TEAM AUTO M. C. NO.	
				1ST MAN No. ______ RATE ______		2ND MAN No. ______ RATE ______			
ORDER No.	LOCATION OF WORK	DESCRIPTION OF WORK	CHARGE	HRS.	AMT.	HRS.	AMT.	HRS.	AMT.
REMARKS:			TOTALS						

(OVER) CORRECT APPROVED

FORM 4.



CONSOLIDATED GAS ELECTRIC LIGHT AND POWER COMPANY OF BALTIMORE

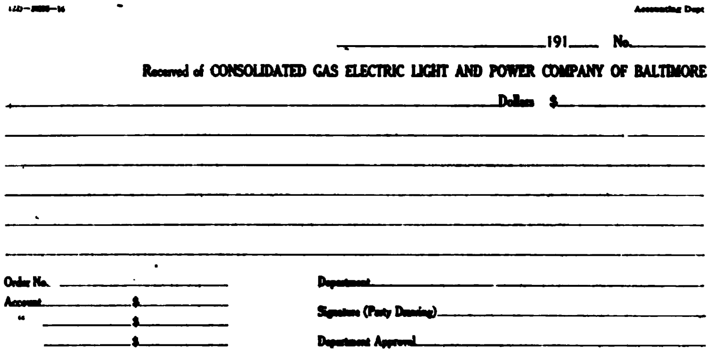
TIME REPORT

NAME________________ CHECK No.________ DEPARTMENT________________ DATE________________

NAME________________ CHECK No.________ TEAM AUTO No.________

ADDRESS	JOB No.	ACCOUNT	AMOUNT		ADDRESS	JOB No.	ACCOUNT	AMOUNT	
			LABOR	AUTO				LABOR	AUTO
OVERTIME									
APPROVED:					TOTAL HRS. AMT.				

FORM 5.



[illegible]

Accounting Dept

________________191___ No.________

Received of CONSOLIDATED GAS ELECTRIC LIGHT AND POWER COMPANY OF BALTIMORE

________________________Dollars $________

Order No. __________

Account________$________

" ________$________

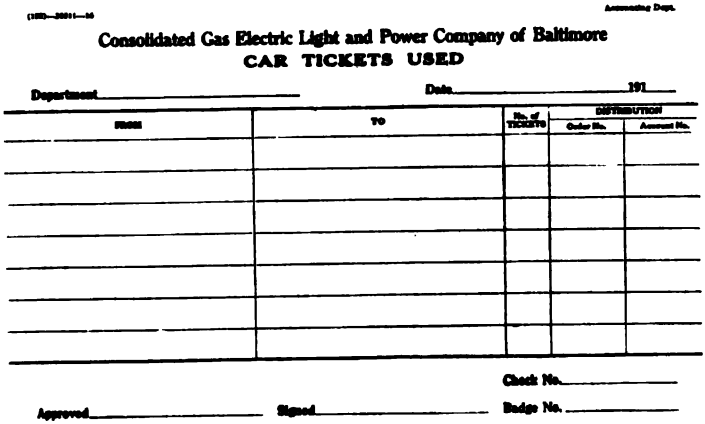
________$________

Department________________

Signature (Party Drawing)________________

Department Approval________________

FORM 6.



[illegible]

Accounting Dept.

Consolidated Gas Electric Light and Power Company of Baltimore

CAR TICKETS USED

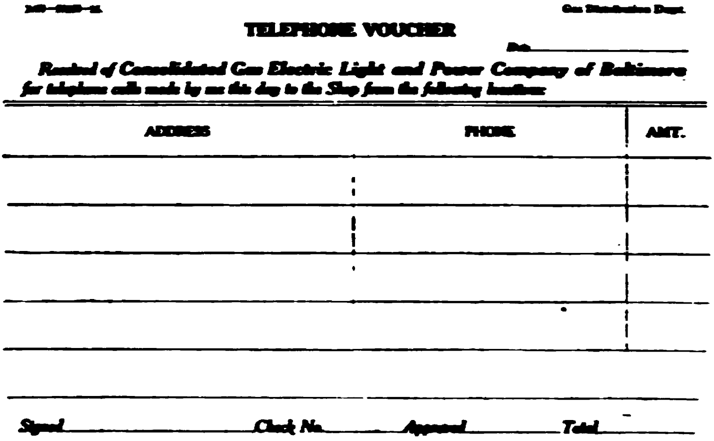
Department________________ Date________________191___

FROM	TO	No. of TICKETS	DISTRIBUTION	
			Order No.	Account No.

Check No.________

Approved________ Signed________ Badge No. ________

FORM 7.



Gas Distribution Dept.

TELEPHONE VOUCHER

Date________________

Received of Consolidated Gas Electric Light and Power Company of Baltimore for telephone calls made by me this day to the Shop from the following locations

ADDRESS	PHONE	AMT.

*Signed*____________ *Check No.*______ *Approved*________ *Total*______

FORM 8.

The Cost Records.

The only form used in compiling the installation costs is known as the "Job Envelope" (form 9).

An envelope is used for this work in order that all original data can be filed with the cost record for future reference. This form is made in four colors for convenient reference in filing, namely:

White—House Piping Work,
Buff—Range Installations and Miscellaneous Work,
Green—Gas Fixtures,
Gray—Water Heaters.

The printing on each form is identical, and the following method of compilation is used in all cases:

Upon receipt of the original sales ticket in the office, it is examined to see if any items requiring installation are included therein. If so, a "Job Envelope" is immediately opened, using the Sales Ticket number as the Job Number and the information filled in as shown at top of form with the exception, of course, of the completed date and the cost.

([illegible])—[illegible]—16

Accounting Dept.

A/C ______

CONSOLIDATED GAS ELECTRIC LIGHT AND POWER CO. OF BALTIMORE

Code ______

Customer ______

Order No. ______

Date Issued ______

Address ______

Selling Price

Salesman ______ Extras, $ ______ Cr. No. ______ $ ______ Date Comp't ______

Cost ______

Date	Ticket	Material		Mechanic	Hrs.	Amount	Auto	Car-fare	Date	Ticket	Tel.	Misc.	Fixtures		Remarks
		Debit	Credit										Debit	Credit	

SUMMARY: Fixtures ______

Material ______

Labor ______

Auto Expense ______

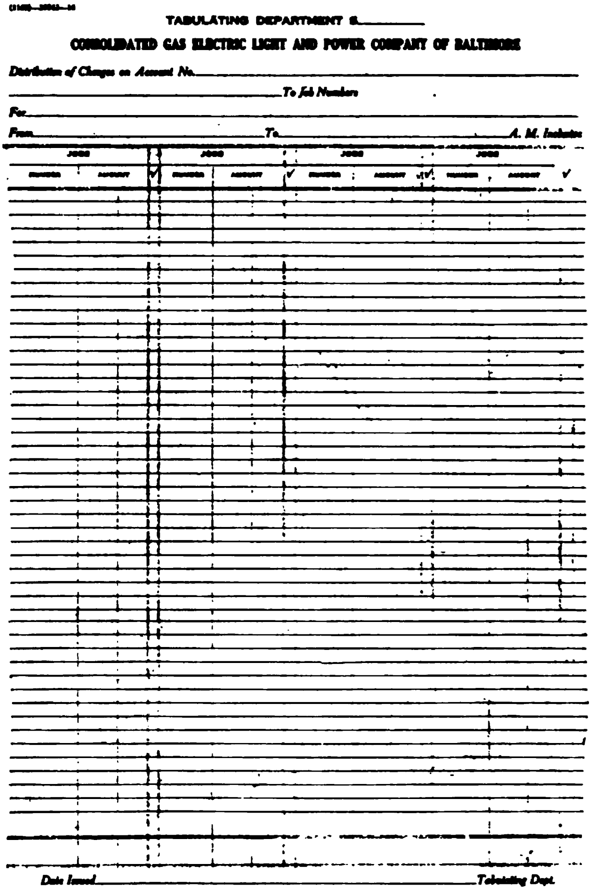
Car-fare ______

Telephone ______

Miscellaneous ______

FORM 9.

As the job progresses the duplicate "Store Orders" and "Store Credits" after being priced and extended in the storeroom are sent to the Merchandise Office and are entered against the proper job on the face of the Job Envelope and the Store Orders and Credits filed therein. The same procedure applies to Car Tickets, Telephone Calls and other Miscellaneous Expense vouchers.



TABULATING DEPARTMENT S.________

CONSOLIDATED GAS ELECTRIC LIGHT AND POWER COMPANY OF BALTIMORE

*Distribution of Charges on Account No.*________

________*To Job Numbers*

*For*________

*From*________*To*________*A. M. Inclusive*

*Date Issued*________*Tabulating Dept.*

FORM 10.

The workman's time sheet showing both direct labor and transportation, after being approved by the foreman, is sent to the Pay Roll Bureau where the labor and transportation rates are entered on time sheet, extensions made and the total day's time entered on the Pay Roll to the workman's credit.

The time sheets are then sent to the Tabulating Department where a Hollerith card is punched for each item charged to a job or operating account number (form 10).

Each week all the cards charged to the controlling account of the cost system are sorted out in Job number order and the amount of labor and transportation charged to each job tabulated and reported to the Merchandise Office where these items are recorded under their proper headings on the Job Envelope.

Upon completion of the job, the workman turns in his duplicate of the sales ticket with his report, which, after approval by his inspector, releases the triplicate from the Installation Department office. The triplicate is dated and stamped completed and forwarded to the Merchandise Department as a notice of completion. Upon receipt of the triplicate it is filed in the "Job Envelope" and the cost record on that job closed, by adding the overhead expenses, consisting of the Storeroom and Tool Expenses previously mentioned and the "supervision" consisting of all indirect costs of the Installation Department. This latter item is a fixed percentage based on the total cost of material, labor and miscellaneous direct expenses.

After completion of the job the original sales ticket is immediately released and sent to the Bookkeeping Department to be charged to the customer's account. This is done before the Cost record is closed, and is accompanied by a daily report (form 11) giving only the order number and the amount of the sale.

This form is made in duplicate, the latter being retained in the Merchandise Department, and when the cost record is complete and closed, the cost is entered thereon opposite the sale. From the total of the daily summaries shown at the bottom, a Journal Entry is made up closing out the work completed and billed to customers during the month.

(1014) 20523 - 16. Accounting Dept.
Date__________________191___

REPORT OF ORDERS SENT TO BOOKKEEPING DEPARTMENT FOR BILLING TO CUSTOMERS; AND RECORD OF COST.

CODE__________

ORDER NO.	AMOUNT	ADR.	COST	MDSE.
	Material___		Cost Mdse._	
	Labor____			
	Misc.____		Cost Inst._	
	TOTAL____			

FORM 11.

After closing, the completed "Job Envelopes" are filed in the completed file and from these records the average cost of installing each kind of appliance is tabulated, and, together with the cost of the appliance itself, forms the bare cost on which selling prices are based.

3. SELLING EXPENSES.

Selling Expenses cover all those expenditures which have to do with the entire sales organization and which can be allocated to the various sales units, if the business is departmentalized or where more than one store is operated. In our organization we have 14 sales units, namely,—

Eight retail stores.
Two outside sales forces (gas and electric).
Shop orders.
Industrial power salesman (electric).
Industrial fuel salesman (gas).
Garage department.

All expenses are charged to the department involved as well as classified as to the nature of expense. This can be best explained by a brief resume of our merchandise classification.

*Sales Department Salaries * Local.*

This will include the salaries of salespeople and store executives where directly chargeable to specific locations.

Sub-divide as to sales divisions.

Salespersons' Commissions.

This account should be charged with the commissions allowed salespersons in the Merchandise Department.

Sub-divide as to sales divisions.

Solicitors' Commissions.

This covers the amount paid to the general solicitors for merchandise sold by them, their flat salaries being charged direct to New Business.

Sub-divide as to sales locations.

Stores Supplies and Expense.

This will include the cost of display and all other expense in connection with operating the various stores, also

Alterations and repairs to store equipment.
Janitor service.
Heat, light and power.

Sub-divide as to sales divisions.

Delivery Department Expense.

This account is to be charged with the time of automobiles, wagons and other vehicles used in the delivery of merchandise to customers' premises. Also the labor of all employees when engaged as drivers in the delivery of merchandise. Charges to this account should not be sub-divided but the total amount charged at the end of the month should be pro-rated over the various sales divisions to which they apply.

Store Demonstrations.

This account should be charged with all salaries and expenses in connection with demonstrating merchandise which is applicable to the Merchandise Department. Sub-divide as to sales locations.

Rentals.

This account should be charged with all rentals or properties whether leased or owned by the Company, which is chargeable to the Merchandise Department where same can be applied to specific sales locations.

The rental of company owned properties will be arrived at as follows:

This item will be a flat rental for the use of each premises, occupied by the Merchandise Department sufficient to cover taxes, water rent, insurance on property and interest on the value of the property occupied. Sub-divide as to sales divisions.

4. GENERAL EXPENSES AND FIXED CHARGES.

These items consist of all expenses of the Merchandise Department which are general in their nature and cannot be charged to a specific sales unit, and are as follows:

Clerical Salaries and Expenses.

1. Merchandise Department.
2. Cost Accounting Department.
3. Accounting Department.
4. Auditing Department.
5. Book-keeping Department.
6. Collection.
7. Credit.
8. General Service.
9. Purchasing Department.

Charge to the respective sub-divisions all clerical salaries and expenses applicable to the Merchandise Department. The amount to be charged to the Merchandise Department under sub-accounts 3 to 9 inclusive will be a flat monthly charge covering the proper proportion of the salaries and expenses of these departments, agreed upon between the heads of the respective clerical departments and the head of the Merchandise Department after a careful analysis of the cost and value of the work performed by these departments for the Merchandise Department.

Executive Salaries and Expenses.

This will cover the salaries of those employees of the Merchandise Department having jurisdiction over all phases of this department's work.

Traveling Expenses.

Charge to this account all amounts paid out to cover traveling expenses in connection with the Merchandise Department.

Advertising.

1. Salaries and Expenses.
2. Newspapers, Booklets, etc.
3. House Demonstrations.

Charge to the respective sub-divisions as shown above all expenses in connection with advertising merchandise applicable to the Merchandise Department.

Rentals.

This account will be charged with rentals as follows:

Leased Property.—(Occupied by those sections of the Merchandise Department not directly chargeable to specific sales locations.)

Company-owned Properties.—This item will be a flat rental for the use of each premises occupied by the Merchandise Department sufficient to cover taxes, water rent, insurance on property and interest on the value of the property occupied. This account, however, will cover only the rentals applicable to such part of the Merchandise Department as is not chargeable to the respective sales locations.

Insurance and Taxes.

This will cover the insurance paid on stock and fixtures of the Merchandise Department and taxes of the personal property assessable against them. It will include these items when applicable to general stock and fixtures of the Merchandise Department as a whole, as well as when chargeable to the stock and fixtures of specific locations.

Inventory Expense.

This account should be charged with all salaries and expenses incurred in connection with the taking of inventories of merchandise applicable to the Merchandise Department.

Uncollectible Merchandise Bills.

This will cover the amount of all accounts which are deemed worthless and charged off to profit and loss.

Non-payment Recovered Merchandise.

This will cover the cost of removal and any loss in connection with the recovery of merchandise on account of nonpayment (including cost of putting such recovered merchandise in saleable condition).

Policy Replacements of Merchandise.

This will cover the cost of replacing merchandise on customer's complaints where the cost of such replacement cannot be charged to a defect in the article itself, and therefore chargeable to the foregoing account, Defective Merchandise Replaced or to Defective Installation Work. This account will also cover cost of putting such recovered merchandise in saleable condition.

Interest on Investments—Furniture and Fixtures.

This will include 5 per cent. interest on the amount of investment on furniture and fixtures in the Merchandise Department.

Interest on Working Capital—Merchandise.

This will include 5 per cent. interest on the amount of merchandise stock on hand based on the ledger balance at the end of each month.

Interest on Working Capital—Accounts Receivable.

This will include 5 per cent. interest on the merchandise accounts receivable outstanding at the end of each month.

This completes all the elements entering into the cost of a sale in our company except "Profit" which is simply that elusive goal which is the object of all business and is as largely dependent on volume of sales as on any one of the elements of cost. "The cost of Goods Sold" varies somewhat inversely with the volume of business; the Installation Cost, only insofar as the volume spreads the Installation overhead. The Selling Expense increases, but not proportionately with the volume, while the General Expenses are nearly fixed regardless of the sales.

In conclusion it might be well to consider the advisability of a unit cost system for Appliance Installations. Several other methods are in vogue in other companies and have been in our own.

One method used by us several years ago was to charge all costs in connection with Gas Appliance Connections to one account in the American Gas Institute Classification, namely "Gas Appliance Connections" and credit the income from this work to the same account. The credit balance being supposed to show the profit on the business and if a debit balance developed the loss, or as sometimes considered the cost of obtaining the increased consumption of gas, and properly includible in the Gas Operating Expenses.

The other method was identical in principal and method and simply differed in that several accounts were used, each representing the cost, income and profit (if any) on a particular class of Installations, such as Ranges, Water Heaters or House Piping.

The second method was an improvement on the first, although it still contained the same fallacies in that it was an attempt to locate the profitable business and a first realization that the merchandise sold by a gas company should produce a return of its own and not simply be sold at cost or less to produce gas consumption.

We found the foregoing methods contained two important fallacies:

First.—Accurate unit costs were more or less estimates, as the only direct costs could be obtained from the fitters' report of labor and material used, all other direct and indirect expenses being someone's estimate as no basis for pro-rating costs was obtainable. Accurate costs being necessary for fixing Selling Prices whether the sale was to be made for profit or for gas consumption, this first objection alone justified a unit cost system.

Second.—Neither method really showed a true profit or a true loss at the end of any month, as the work in course of installation ran from one month into another and the sale or income was credited in a later month, while part and sometimes all the cost was charged in a previous month. This made the account, even as a gauge on the business as a whole, very misleading to those who directed the New Business policies of the organization.

With the system outlined it has developed that the cost of operating a unit cost system giving accurate and dependable results is only slightly higher than the former methods and considering the uncertainties and pitfalls eliminated and the better ability to check and reduce costs of installation, is considerably more economical and efficient in the final analysis.

THE CHAIRMAN: Mr. Lohmeyer's paper is open for discussion. This is a very interesting paper and I hope we will have full discussion of it. He has devoted a great deal of time and care to the preparation of it and I think is entitled to our thanks.

MR. T. V. PURCELL (Chicago): I am interested to know how you handle at present the situation described in this paragraph which appears on the last page:

"Neither method really showed a true profit or a true loss at the end of any month, as the work in course of installation ran from one month into another and the sale or income was credited in a later month, while part and sometimes all the cost was charged in a previous month. This made the account, even as a gauge on the business as a whole, very misleading to those who directed the new business policies of the organization."

Under the new method are you able to credit sales against the expenses incurred by them?

MR. LOHMEYER: Do you mean how was the old method handled?

MR. PURCELL: No. In the new method are you able to credit sales against the expense incurred by them?

MR. LOHMEYER: Yes, because each job is handled as an individual installation. It is a unit cost, where formerly the work was simply grouped.

MR. PURCELL: Do you mean you have a separate account for each installation?

MR. LOHMEYER: All expenses in connection with that particular job are charged to the sales ticket number, which is used as a job number, and each installation is therefore kept separate, just the same as if we had a separate account, but it is all handled through one general account.

MR. PURCELL: In a sort of sub-ledger?

MR. LOHMEYER: Yes; it is in suspense until closed.

MR. PURCELL: I see. Thank you.

MR. F. H. PATTERSON (Rochester, N. Y.): I desire to congratulate Mr. Lohmeyer on this mighty well thought out paper, and I am certainly pleased to get it at this time, because this is a matter that has been giving us considerable concern during the last two years. I think we have been concerned chiefly over trying to put this department on a self-sustaining basis. In doing that it is necessary to provide a classification of accounts and understand what constitutes the cost, and we have prepared a classification in our company, but we find that it does not cover all the items which Mr. Lohmeyer has in his classification included in this paper. I think that he has a more complete classification, and I expect we will adopt some of the suggestions he has made here.

The idea, too, of carrying this activity in practically a Work in Progress or Suspense Account until the work is completed, has another very good phase to it. At the present time we are carrying ours in our regular revenue account, and because of the fact that this account is charged with work completed or in process one month, and the consumers are filled in on another, we have an unusual loss in one month and an unusual gain in the next, so that we have to wait until several months have elapsed until we have found out how the trend is. But in carrying it in a Work in Progress or Suspense Account, that feature is eliminated.

The question of keeping the individual cost on each job also was the cause of some concern with our company, and we have not done that yet, but I am of the personal opinion that it could be done advantageously. However, the management will have to decide that.

In the matter of classification of accounts, there must necessarily be some arbitrary dividing of cost. For instance, we have Advertising. There is no doubt but what our general advertising for the sale of merchandise also includes a certain amount of benefit accruing to the sale of gas and there must be some arbitrary method of dividing the advertising expense between the sale of merchandise proper and the sale of gas. That, too, concerns the solicitor's salaries or their compensation, whether they are on a bonus plan or not. There are other accounts such as the salaries of the management of this department. While they are strictly concerned in selling appliances they are also concerned in increasing the sale of gas. Of course, if this classification is enlarged along the lines that Mr. Lohmeyer suggests, it will bring in all the true costs of selling this merchandise, and the answer is volume of sales in order to overcome that high cost.

I would like to ask Mr. Lohmeyer how he keeps his Tool Account, for all his activities, regardless of the Merchandise Account.

MR. LOHMEYER: We carry a Tool Expense Account to which all expenses of the tool store room and expenses in keeping the tools in workable condition are charged. The tool expenses at the end of each month are pro rated over all of the operating accounts, both gas and merchandise, on the basis of the direct labor charge.

MR. PATTERSON: That applies to small tools, as well as large?

MR. LOHMEYER: All tools. We use, of course, a fixed percentage. The present percentage is about 4 per cent., which is an arbitrary percentage and approximately covers the tool expense each month.

MR. F. M. JAMES (Aurora, Ill.): I would like to ask Mr. Lohmeyer in what way he reconciles his pay roll charges with the individual tickets. Does your pay roll show the amount chargeable to each job, or do you depend upon the foremen's record of the time turned in on the ticket? Do you have any trouble reconciling your pay roll account with the amounts of labor turned in on the job ticket?

MR. LOHMEYER: No, none whatever. The workman places on his time sheet the controlling account number and the job ticket number on which he was working, which, of course, is checked by the foreman when he approves the time sheet.

MR. JAMES: And the amount chargeable to each job is shown on the pay roll?

MR. LOHMEYER: On the time sheet, and it is taken from there with the aid of the Hollerith machine, and distributed, and tabulated by pay roll periods.

Mr. H. L. Judd (Oak Park, Ill.): I would like to ask Mr. Lohmeyer what he means by 4 per cent. to his Tool Account. Is it 4 per cent. of the cost of the job that you charge?

Mr. Lohmeyer: Four per cent. based on the direct labor charge to the job.

Mr. Judd: Four per cent. of the labor charge is added arbitrarily to tools?

Mr. Lohmeyer: To the cost of the job, to cover the tool expenses.

Mr. Charles M. Cohn: I might say that the purpose of this classification, in Baltimore, is to not only ascertain the cost of doing work in order that proper prices may be placed on merchandise sold, but also for the equally important purpose of economical work. The system that Mr. Lohmeyer has outlined might appear to some to be somewhat cumbersome, and perhaps unnecessarily extended, but it is no more so than would obtain in any large merchandise houses or in any contracting concern that does installation work.

Unfortunately, in the gas industry, the number of real merchants is rather few and the methods of doing installation work up to this time have not been in conformity with the practice of concerns that do work of this character.

We say that every dollar saved in this kind of work is a dollar made, and it is on that adage of a dollar made being a dollar saved that large mercantile concerns and contracting concerns make their success.

The fact that the merchandising business of gas companies should be placed on a self-sustaining basis is generally conceded now, because the utility of gas for industrial, commercial and domestic purposes is well accepted by the public, and it is not necessary to do work or sell appliances at a loss in order to bring about the utilization of gas. So that on the whole I think a statement of a system such as Mr. Lohmeyer has outlined justifies itself, from whatever angle it may be considered.

The Chairman: I will ask the Secretary to read a written discussion that was received on Mr. Lohmeyer's paper.

Mr. Ervin Calhoun (Philadelphia): (Written discussion communicated.) Page 454, Paragraph (B): I am inclined to think this practice is objectionable because it establishes a precedent whereby extraneous elements of expense would be charged into Expense Store Room, thereby opening the way to the evil of overburdening this account with items not directly related to the handling of material, besides, when passing a transportation invoice it is no more clerical work to classify against a specific article than to charge to Expense Store Room.

For reference purposes, especially when compiling selling prices and other data, we find that the information as to cost of transportation is quite valuable if recorded on the stock ledger with the purchase price.

Page 454, Paragraph (C): This appears to be a rather elaborate routine to replace the comparatively simple method of deducting the amount of the cash discount from the invoice and posting the ledger accordingly with what is really the true purchase price and fundamentally is the net cost of the material.

To segregate the cash discount certainly involves more clerical labor in opening a special account for that purpose, and it would seem wrong in principle to close such an item into a handling account.

Page 454, Paragraph (D): Our experience has been that most breakage is due to natural causes, and, therefore, might properly be apportioned to the Merchandising Accounts to which material of the class broken is ordinarily charged, on the basis of percentage of amounts of each account to the total issue of that class of material. In this way one determines the value of the total breakage and is enabled to adjust the selling price to include that factor. While some breakage is due to careless handling and might be as properly charged against handling, most breakage is due to the fragile character of the material and the cost of breakage should be borne by the sales accounts.

Page 455, 2—Cost of Installation: The remainder of this paper impresses me as being a very comprehensive method of obtaining costs, but I am inclined to think the cost of operating a unit cost system would be much higher than the method mentioned in the first paragraph of page 474, which produces an average cost, and unit costs may be compiled from time to time by checking a number of installations under varying conditions.

THE CHAIRMAN: If there is no further discussion I will ask Mr. Lohmeyer to close the discussion.

MR. LOHMEYER: In my paper I admitted that the first two items of Mr. Calhoun's discussion were open to criticism from a strictly technical accounting viewpoint. There is one point as to why we handle it in that way that might be of interest. Where you have a great volume of merchandise business the extensions necessary in figuring the cost under any unit cost system, in particular on small items of material, is great enough without causing you more decimals in your unit cost by dividing a small freight bill up among the 150 items that it may cover and by dividing your 2 per cent. cash discount among a great many items. By the method we use we eliminate a great many of the long decimals in our unit cost of materials, and that is the fundamental reason of our using that method.

As to his closing paragraph, I may say that we have not found that a unit cost system is very much more expensive to operate than the former methods that we used.

THE CHAIRMAN: I think that covers the subject very well. I am sure that we are greatly indebted to Mr. Lohmeyer for his paper.

The next order of business will be the report of the Committee selected to present three names to the Nominating Committee, one of whom is to be selected as Vice-President of the Accounting Section for the succeeding year. I would be glad to hear from the Chairman of the Committee.

MR. T. V. PURCELL (Chicago): The Committee appointed to recommend the names of three members of this section as candidates for the office of Vice-President, reports the following names:

Mr. Ewald Haase, Milwaukee.
Mr. G. W. Curran, Philadelphia.
Mr. Robert Grant, Boston.

If these names are approved by the Section, they will be forwarded to the general Nominating Committee, and one of the three members will be selected as the nominee for the office of Vice-President.

T. V. PURCELL,
JANSEN HAINES,
H. W. PECK.

MR. CHARLES M. COHN: Mr. President, I move that the report of the Committee be approved.

(Motion duly seconded and carried unanimously.)

THE CHAIRMAN: I wish to thank the Committee for their work and efforts in this direction.

The next paper is "Outline of Credit System in Operation by the Peoples Gas Light & Coke Company, Chicago, Ill.," by Mr. Robert Blair. This is the last paper on the program, but not the least in importance, by any means. It is on a very important topic. We would be glad to hear from Mr. Blair.

OUTLINE OF CREDIT SYSTEM IN OPERATION BY THE PEOPLES GAS LIGHT & COKE COMPANY, CHICAGO, ILL.

Systems for handling the granting of credits have in the last few years been raised to a point of efficiency vastly superior to the methods in operation long ago. Time was, when no co-operation existed between credit men in lines of business that were competitive and when, to seek information from sources of this nature in an endeavor to ascertain a prospective customer's record for honesty and ability to pay promptly was inviting the risk of receiving evasive information, or such information as to be misleading. Consequently, the gambler's chance entered largely into the making of credit decisions.

Credit men were not honest with themselves and, therefore, made it possible for the dishonest trader to obtain his line of goods on liberal credit terms. Later both credit men found out that their respective houses had been defrauded by the same party, whereas if honesty of purpose had been shown one with the other, such losses undoubtedly could have been prevented. Thanks to the good work of the National Association of Credit Men this condition practically no longer exists.

It is possible and profitable to-day, for credit men, even in competitive lines of business, to give and receive reliable credit information regarding prospective or former customers. Credit methods of gas companies in the past have not been based on any fundamental or recognized rule; each seems to have drifted along governed by local conditions, and most of them with hide-bound rules for cash deposits required from new customers to secure the payment of bills.

It is apparent from replies received to inquiries sent to other gas companies throughout the country, regarding the credit standing of some customer recently moved to Chicago, that many of the smaller companies still adhere to narrow credit rules, while a number of the larger and some of the smaller companies have adopted more liberal policies, which have proved of mutual benefit.

The exchange of credit information between gas companies has resulted in good to the company and consumer; in this manner a delinquent is frequently located for the company from whom inquiry is made, or if the applicant has a good credit record it is only justice for one company to furnish such information to another company, thereby establishing a credit record for the customer, who is a stranger in a strange land. If the record shows prompt payment for a customer while he was living in Milwaukee, it should be taken as an index that he will be equally as good pay in Chicago.

In the foregoing, reference has been made only to new customers who occupy flats and residences; in extending credit to new customers engaged in business, consideration must be given to the nature of business, location, reliability, rating, hazard, bank reference and many other things.

The following is a concise outline of the credit methods in operation by The Peoples Gas Light & Coke Company at the present time.

Several years ago this company required its customers to furnish satisfactory credit information before turning on the supply of gas. It even required the customer's signature to an application before turning on the meter.

As the population of the city increased, it was found necessary to establish a number of branch stores and to improve and increase the facilities for receiving applications for gas at these branches and by telephone.

It was found that branch stores and telephone service soon became very popular, for the reason that service to customers was expedited. A better feeling was also created between the customer and the company. When the customer learned that he could get reliable service by calling the gas company's office by telephone, and that a great deal of inconvenience could be eliminated by so doing, he was quick to take advantage of the opportunity.

In 1915 this company received 45 per cent. of all applications for gas by telephone and 26 per cent. at branch stores.

It will readily be seen that under these improved conditions, it became necessary to improvise a credit system that would not impede quick service to customers. The following routine was, therefore, placed in effect and seems to have worked to the mutual benefit of the company and its customers.

All customers who make applications for gas, either by telephone, at the main office or branch stores, are asked to answer a regular set of credit questions, namely: Where did you last use gas in this city; if never in this city, where did you last use gas in any other city and the name of the company that supplied you? If the customer is an entirely new consumer he is asked to furnish the name and address of his employer, occupation and name and address of at least one reference. See form No. 6.

Gas is turned on at the earliest possible moment and investigation is made with regard to credit information at some later period.

All applications for gas before reaching the Credit Department have been executed and the gas turned on pending the credit investigation. The Credit Department then assorts them into two classes, previous and new consumers.

Those applications designated as previous consumers show a class of patrons who formerly used gas and are moving from one address to another, ordering the gas off and on. This class of applications is taken in hand by a small night force of men who are qualified to pass on credit business of this sort. The reason for doing this work at night is that records are more accessible for investigation of the accounts, as the ledgers are in use continually during the day.

The customer's account at the address he is leaving is examined and if the payments shown thereon are reasonably prompt and the amount left unpaid not unreasonably large the final bill for the old location is ordered charged on the first bill rendered at the new location. The application is then approved and sent to the permanent file.

Where investigation develops conditions showing that the customer has been slow pay and the amount left unpaid at the time of moving warrants immediate attention, these applications are given to a collector at once for collection of the delinquent amount.

NEW CONSUMERS.

Applications received from persons who say they are new consumers are assorted into six classes and action taken thereon, as follows:

Class No. 1.—Applications which for various reasons do not show proper credit information. These are received largely from a transient class of people whose place of employment is indefinite, and whose occupation is such that credit investigation is necessary. They are also received from occupants of small places of business, restaurants, saloons, barber shops, and rooming houses, all of which are usually considered somewhat of a risk. In this class are also included a large number of applicants who are foreigners, and understand but very little English.

All of the facts referred to above seem to indicate that the best way to determine the standing of such applicants is by investigation on the applicant's premises or in the immediate vicinity and at his place of employment.

First of all it is necessary to ascertain if the right name has been given and that applicants are what they have represented themselves to be, namely, new consumers. This investigation is made by what we call "final bill collectors" who in turn become credit investigators when that class of work is given them to handle in conjunction with their final bill collections. The object, of course, in the street investigation is to determine whether this class of accounts can be carried without cash deposits.

The information obtained by these investigations is also of value for comparison with cards which are kept in a file in the Credit Department. These cards show records of the last address at which a customer used gas and left an outstanding bill. They also show all other delinquent accounts for a period of ten years, whether gas was used in the customer's real or an assumed name. Any other information regarding non-payment of bills, places of employment, etc., is entered on the card and the file is usually the first reference used when a new consumer or so-called new consumer makes application for gas. See form No. 1.

Class No. 2.—This class consists of applications where place of employment given is such that employers can be written to and if favorable reply is received as regards length and permanency of employment the application is approved and sent to the permanent file. Applications of this kind are not sent out of the office unless an unsatisfactory reply is received. See form letter No. 1.

Class No. 3.—This class shows applicant's place of employment with large manufacturing concerns where laboring classes are generally known by check number only. In such cases it would not be advisable to write to the employer. Therefore, a private reference is used (see form letter No. 2) usually some neighbor or friend and if a favorable reply is received these applications are also approved and sent to the permanent file. If the reply is not satisfactory these applications then become part of class No. 1. This class is not sent out of the office unless developments show that such a course is necessary.

Class No. 4.—In this class of applications we find the names of persons living in good neighborhoods, owners of the property in which they reside, professional men, men with official positions with business concerns, etc.; in other words, a reasonably high class of people. This element, however, is very small compared to the whole and their applications are approved without further credit investigation.

Class No. 5.—Consists of applications where the place of employment is generally given and also the address of the gas company at some location from which the applicant has recently moved. The gas company given as reference is written to and the credit of the account established through that medium. See form letter No. 3.

Class No. 6.—Composed altogether of business concerns who have established rating with Dun or Bradstreet. This class is disposed of according to the rating shown. If the consumption of gas is to be large and if there is any question about the rating as given in Dun's, a special report is asked for.

To enable us to give prompt service in turning on gas necessitates that applications be taken by fitters, turn-on men, solicitors, and clerks at branch stores. These employees not having very much knowledge of the operation of the Credit Department, frequently fail to obtain the proper credit information and most applications taken by them go into class No. 1. Constant effort is made to correct this condition, but apparently it is something that is hard to overcome. These employees may be efficient in their own line, but frequently fail to obtain essential credit information.

DEPOSITS.

When accounts have been investigated and it is found for various reasons that a deposit is deemed necessary to secure the payment of bills, such accounts are placed in a separate class. A form letter is sent to the customer to the effect that under our rules a deposit will be required as continuing security for the payment of gas bills (see form letter No. 4) and that on a certain day, which is usually forty-eight hours from the date of the letter, our collector will call to collect same; upon failure to collect, the collector serves a final notice which expires in forty-eight hours (see form No. 623). If the terms of this notice are not complied with the supply of gas is discontinued by the collector (see form No. 643). The entire operation from the inception of the application to a point where the gas is discontinued covers an average period of ten days. Experience and statistics show that the losses sustained where gas has to be finally shut off is proportionately very small compared with the benefits received by the large number of customers who desire prompt service and whose standing in the community entitles them to it.

The amount of deposit is generally based on the amount of consumption as shown by readings taken by the credit investigator and the minimum deposit is $5.00. (See forms No. 656 and No. 106-A.)

At this point it might be well to state our whole endeavor is to take as few deposits as possible and they are called for only where investigation develops a condition that indicates unless the deposit is secured we would sustain a loss.

It would be as futile to demand that customers pay a deposit of too large an amount as it would to ask for one of insufficient amount, for in this state gas companies pay interest on customers' deposits. Several years ago the proprietor of a saloon made application for gas; under the system then in operation he was required to make a deposit of $50.00 which was too much to secure payment of bills averaging $12.00 a month. He paid the deposit without protest and said he would like to make an additional deposit of $5,000.00 The application clerk informed him that we could not take deposit in that amount and he asked to see the manager. The manager, assuming that the man had been partaking of some of his own stock of goods before coming down town, did not waste much time with him, but politely said that the gas company was not doing a banking business. You may imagine the manager's surprise when that saloonkeeper said he was in dead earnest and that he would sign a check on the spot. He would rather have a gas company certificate of deposit than a Government bond. Moral: Beware of overtaking deposits.

The Peoples Gas Light & Coke Company also accepts guarantees in lieu of cash deposits from patrons of the company who have established accounts in good standing and who are willing to act as guarantors. Signatures to guarantees are obtained both by collectors and by use of form letters (see form letter No. 5). It should be borne in mind that the guarantee class is a very small percentage of the whole, but the one that needs the most care and attention.

The present system for handling consumers' applications as outlined has been in operation for several years with marked success.

Years ago when the taking of deposits was left to the application clerks there was an arbitrary rule that the deposit must be paid before gas would be turned on. This worked an injustice to the customer and to the company. Under the present system there is no snap judgment and a reasonable time is given to comply with the request for deposit, and also an opportunity given to customers to present their side of the case or give reason why the deposit should not be exacted.

From the foregoing it might be inferred that the writer considered the system as outlined, perfection, but unfortunately it is only effective, for when we consider the element of people who set themselves out to beat any established credit system, they having systems of their own which they pit against ours, it will be readily seen that no matter what the system may be, it is bound to have its weak points. However, it has been clearly demonstrated that the system has a decided moral effect on this class of people and is instrumental in digging them out of their holes and making them less bold in using crooked methods in their business transactions with the gas company.

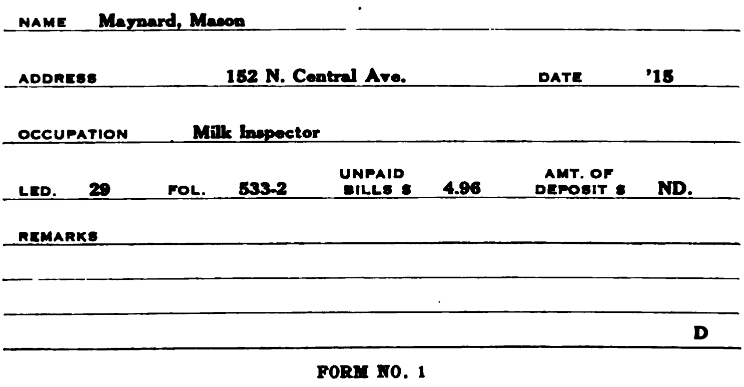
EXCERPT FROM THE PEOPLES GAS LIGHT & COKE COMPANY CREDIT DEPARTMENT REPORT FOR 1915.

Applications examined		311,324
Deposits demanded	8,181	
Demands canceled	1,672	
Total number of deposits made		6,509
Credit inquiry letters sent out		27,243
Replies received		23,546
Meters cut off on account of non-payment of deposit		2,621
Accounts guaranteed		3,431

It will be observed from these figures that deposits were demanded in only 8,181 cases out of a total of 311,324 applications for gas.

One thousand six hundred and seventy-two demands were canceled, leaving 6,509.

The number of new customers who made application was 62,116, or 20 per cent. of all applications received. Of this number 6,509 were required to pay deposits. This number is equal to 10½ per cent. of all new consumers who made application during the year. The number of deposits taken was 2⅗ per cent. of all applications received.



NAME **Maynard, Mason**

ADDRESS **152 N. Central Ave.** DATE **'15**

OCCUPATION **Milk Inspector**

LED. **29** FOL. **533-2** UNPAID BILLS $ **4.96** AMT. OF DEPOSIT $ **ND.**

REMARKS

D

FORM NO. 1

APPLICATION FOR GAS

METER

Order No. ______

Date Cut Off or Cut Off Issued ______

______

Taken by ______

______

Phone No. ______

Address ______ Fl. ______

Last Supplied at ______ Fl. ______

Name ______
(If New Consumer)

Employed by ______

Address ______ As ______

Reference ______

Address ______

Occupied as* ______

Key for Premises ______

Fixtures up ______

Deposit, $ ______

Number ______

Date ______

Class No.	Dist. No.	Execute T.O. or Set
Ledger No.	Page	
	Folio	

GUARANTEE: In consideration of The Peoples Gas Light & Coke Co. accepting this account without the customary deposit, I hereby guarantee payment of all bills for gas used on the premises specified on this application until I notify the said Company to discontinue the supply of same.

NAME ______

ADDRESS ______

* If domestic consumption designate as flat, residence, rooming or boarding house, basement, hall, private barn or garage; if store, shop, factory or office give nature of business and whether manufacturing, wholesale or retail.

SPACE FOR STAMPS

The subscriber, in consideration of being supplied by The Peoples Gas Light & Coke Co. with manufactured gas in the above named premises, agrees to pay for same as bills are rendered therefor at current rates, and further agrees to the terms and rules as printed on back hereof.

THE PEOPLES GAS LIGHT & COKE CO.

Chicago, ______ 191__ Signed ______ (SEAL)

FORM NO. 6 (FRONT).

TERMS AND RULES

The Company will supply the subscriber with gas only through the meter furnished and owned by or leased to the Company, and will keep account upon its books of the amount of gas registered by the meter, as consumed upon said premises, which books may, as often as once in each month, be inspected by the subscriber, and such account so kept shall be received at all times and in all places and courts as prima facie evidence of the true amount of gas consumed by the subscriber on said premises. Should the meter be found defective in any particular, it will immediately be changed; but in case the meter shall fail to register the quantity of gas consumed, the amount shall be ascertained, as nearly as practicable, at the option of the Company, by the amount of gas registered by another meter set in lieu thereof, or by the amount consumed during the corresponding period for the same premises for the previous year, or by the amount of gas that might reasonably be used at the orifices or burners in the premises occupied by the subscriber during the hours in which gas is usually and customarily used at such orifices or burners for lighting, cooking, or heating purposes.

The subscriber will provide all house piping, and will keep the same in repair, and will provide, free of charge to the Company, a suitable place for the meter and pipes, and will protect the same; and will insure and indemnify loss of meter or injury thereto by carelessness, accident or otherwise; and where the gas is supplied through a prepayment meter the subscriber expressly agrees to be responsible to the Company for all money which has been deposited therein and which is taken therefrom otherwise than by the agents of the Company, and the subscriber will deposit with the Company, from time to time, such sums of money as may be required by it, **as continuing security for the** performance of the obligations of the subscriber to the Company.

All the applications for supply of gas, and all notices to discontinue the same, **must be made in writing to the Company, at its office, and the subscriber will be held responsible for all gas consumed until such** written notice is given and **proper time allowed to take final inspection of the meter.**

Immediate notice, in writing, must be given to the Company, at **its office, of any escape of gas in or about said premises. No light must be taken near an escape of gas and as an additional precaution the gas must be** shut off at the stop-cock **whenever a leak is discovered, as the Company will not be responsible for any damage or injury arising** from any escape of gas.

The Company's agents are to have access to the meter and pipes at all times, to ascertain the quantity of gas supplied and consumed and that the same is passing through the meter and being properly registered, and to stop the supply of gas for non-payment of bills, when due, for any gas furnished to the subscriber at said premises, or elsewhere in the City of Chicago, or for any other cause or purpose which the Company may deem sufficient, and said agents are hereby authorized to enter the premises of the subscriber, at all times, for any such cause or purpose, or for the purpose of disconnecting or adjusting any pipes, meter, or appliances, or for the purpose of removing the meter with connections, or any other property belonging to the Company, the subscriber hereby recognizing the right of the Company to remove said meter for default of the subscriber in any of the terms of any contract with the Company; but it is expressly agreed by the subscriber that nothing herein contained shall mean, or be construed to mean, that the Company shall be required to inspect or examine, or in any wise be responsible for the condition of the said house piping.

SHOP REPORTS

(BACK)

METER

Order No.
Date Cut Off or Cut Off Issued

Taken by

Phone No.

Address Fl.

Last Supplied at Fl.
Name
Employed by
Address As

Occupied as*
Key for Premises
Fixtures up
Deposit, $
Number
Date

Class No.	Dist. No.	Execute T. O. or Set
Ledger No.	Page	
	Folio	

METER-SET REPORT

Company No.
Maker Maker's No.
Size Index Loc.
Date Completed
Fitter

TURN-ON REPORT

Company No.
Maker's No.
Size Index How Off
Date Completed
By

SPACE FOR STAMPS

House No., Floor and "Occupied as"
Verified

Report

* If domestic consumption designate as flat, residence, rooming or boarding house, basement, hall, private barn or garage; if store, shop, factory or office give nature of business and whether manufacturing, wholesale or retail.

THE PEOPLES GAS LIGHT & COKE CO.

Chicago, 191 Signed (SEAL)

FORM NO. 6-A (FRONT).

FEET	SIZE PIPE	FEET	SIZE PIPE

NO.	SIZE	KIND	NO.	SIZE	KIND
		ST. ELLS			NIPPLES
		″			″
		45° ELLS			LG. THREADS
		ELLS			COUPLINGS
		″			″
		TEES			HOOKS
		″			STRAPS
		CAPS			SHELF
		PLUGs			FLANGE UNIONS
		″			5-LIGHT CONNECTIONS
		BUSHINGS			10-LIGHT CONNECTIONS
		″			METER COCK
		REDUCERS			LOCK
		″			

REPORTS—CONTINUED: ____________________

(BACK)

METER

Order No.
Date Cut Off or Cut Off Issued

Taken by

Phone No.

Address Fl.
Last Supplied at Fl.
Name
Employed by
Address As

Occupied as*
Key for Premises
Fixtures up
Deposit, $
Number
Date

Class No.	Dist. No.	Execute T. O. or Set
Ledger No.	Page	
	Folio	

METER-SET REPORT

Company No.
Maker Maker's No.
Size Index Loc.
Date Completed
Fitter

TURN-ON REPORT

Company No.
Maker's No.
Size Index How Off
Date Completed
By

SPACE FOR STAMPS

House No., Floor and "Occupied as"
Verified

Report

* If domestic consumption designate as flat, residence, rooming or boarding house, basement, hall, private barn or garage: if store, shop, factory or office give nature of business and whether manufacturing, wholesale or retail.

THE PEOPLES GAS LIGHT & COKE CO.

Chicago, 191 Signed (SEAL)

FORM NO. 6-B.

NO. ____ AMT. ____

NAME ____

ADDRESS ____

DATE ____ APP. NO. ____

NO. ____

CREDIT DEPARTMENT

NAME ____

AMOUNT ____ DOLLARS

ADDRESS ____

THE PEOPLES GAS LIGHT & COKE CO.

____ COLLECTOR

DATE ____

TEMPORARY RECEIPT

NO. ____

FOR GAS DEPOSIT

RECEIVED OF ____

____ DOLLARS

FOR SECURITY FOR PAYMENT OF BILLS AT

ADDRESS ____ LOC. ____

THE PEOPLES GAS LIGHT & COKE CO.
CREDIT DEPARTMENT

DATE ____ ____ COLLECTOR

THIS IS A TEMPORARY RECEIPT. A REGULAR CERTIFICATE WILL BE MAILED YOU

FORM NO. 656.

COLLECTORS' RETURNS

GAS DEPOSITS Collector____________________

Ledger No.______________ Date________________________

NAME	AMOUNT	

FORM NO. 106-A.

DEPOSIT NOTICE

Address______________________________

M____

As you have failed to comply with the terms of our letter of ____________________requesting a deposit of $__________to cover the amount of your gas bills at the above-named address, you are hereby notified that unless said deposit is made on or before__________________ the supply of gas to your premises will be discontinued.

Very respectfully,

PEOPLES GAS BUILDING

THE PEOPLES GAS LIGHT & COKE CO.

Credit Department

Chicago,____________________

FORM NO. 623.

____

applied to this Company for a supply of gas. This application was accepted and the gas turned on pending an investigation by our Credit Department.

Your name was given as reference by the applicant to aid us in determining whether or not we shall ask for a deposit. We, therefore, request you to kindly fill out the answers to the questions asked in the form below and return it by mail in the enclosed stamped envelope.

We assure you that this information will be held strictly confidential and that your courtesy will be appreciated. Thanking you in advance, we are

Yours very truly,

THE PEOPLES GAS LIGHT & COKE CO.

By

How long have you known the applicant?..............................

Are you connected with applicant
by relationship or otherwise?..............................

If you know any reason why we
should not extend applicant credit,
please give facts below:..............................

....

....

....

DATE................ SIGNATURE..............................

(FORM LETTER NO. 1.)

____

applied to this Company for a supply of gas. This application was accepted and the gas turned on pending an investigation by our Credit Department.

Your name was given as reference by the applicant to aid us in determining whether or not we shall ask for a deposit. We, therefore, request you to kindly fill out the answers to the questions asked in the form below and return it by mail in the enclosed stamped envelope.

We assure you that this information will be held strictly confidential and that your courtesy will be appreciated. Thanking you in advance, we are

Yours very truly,

THE PEOPLES GAS LIGHT & COKE CO.

By

Is this applicant in your employ?..............................

How long employed?..............................

In what position?..............................

Is this position reasonably permanent?..............................

REMARKS..............................

....

....

DATE................ SIGNATURE..............................

(FORM LETTER NO. 2.)

Mr.................................... .... late of
....has applied for a supply of gas at the premises .... this city, and same has been turned on pending a credit investigation.

Will you kindly return this inquiry with the information requested, and oblige.

Date turned on ....

Date cut-off..

Average bill ....

Record of payment ....

Security if any ....

Are all bills paid..

Yours very truly,

THE PEOPLES GAS LIGHT & COKE CO.

By

Order No.............

IM

(FORM LETTER NO. 3.)

Under our rules it will be necessary for you to make a deposit of to cover the amount of your bills. Our representative will call on to collect this amount.

The deposit will be refunded with interest when the supply of gas is discontinued.

Yours very truly,

THE PEOPLES GAS LIGHT & COKE CO.

By

(FORM LETTER NO. 4.)

---

recently applied for gas at and informs us that you will guarantee account, thus relieving of the necessity of making a deposit to secure the same.

If you wish to do this, kindly sign the following guarantee and return to us.

Yours very truly,

THE PEOPLES GAS LIGHT & COKE CO.

By

GUARANTEE

In consideration of The Peoples Gas Light & Coke Co., accepting the above account without the customary deposit, I hereby guarantee payment of all bills for gas used on the premises specified on this application No........., until I notify the said Company to discontinue the supply of same.

Name..... ....

Address ... .

(FORM LETTER NO. 5.)

MR. CHARLES M. COHN: I would like to ask Mr. Blair two questions: One, why is it that the Peoples Gas Light & Coke Company have the minimum deposit of $5.00? Secondly, what system it follows for the return of deposits made by customers after they have reasonably established credit through their dealings with the company?

MR. BLAIR (Chicago): I do not know how the amount happened to be established, but it has always been $5.00. I notice in getting replies from different gas companies throughout the country that some of them have $2.50 or $3.00, and some of them have $10.00. It is generally understood when a deposit is made, if there is reasonably prompt payment for a year the deposit is paid back with accrued interest. Where they move, of course, it is paid back immediately upon request; we even go to the extent of trying to locate them, if they do not call for the money; that is by sending out a form letter telling them to come in and get their money.

MR. H. B. REINACH (New York): In answer to Mr. Cohn's question, the Consolidated Gas Company, of New York, goes periodically over their ledgers and every customer that has had an account with the Company for 3 years and has paid his bills promptly, is notified that the deposit will be returned to him. Our Company takes as low as $3.00 deposit for small apartments. We also require deposits on prepayment meters in houses where the meters have been broken open and the money stolen.

MR. PURCELL: In answer to Mr. Cohn's question as to how the $5.00 was made the basis of deposit, we found that in Chicago about one month was required after a bill became delinquent to carry out our routine of collectors' calls and the serving of final notices. The delinquent customer usually owes us for about two months' bills before his supply can be shut off. It, therefore, requires at least $5.00 to secure us against possible loss.

MR. BLAIR: Yes, that is right.

MR. F. H. PATTERSON: In regard to the matter of turning on the gas, pending investigation, trouble in Rochester was experienced at the application counter through the congestion of people kept there throughout the day while their credit standing was being looked up. We recently adopted the plan of having them sign the application and getting them away from the front of the application counter as quickly as possible in order to prevent that congestion. The company always has the whip hand in a case like that, because they cannot get a supply for more than possibly a night, and in our case they do not get the gas turned on at all until it is investigated, because the credit department has access to it before the order goes out to be completed. We also follow the plan of receiving as few deposits as possible and we go over the books once every year and find out whether any deposit accounts can be closed by refund.

Mr. Purcell: That was exactly our experience in Chicago. When it was our custom to look up the credit of a customer before his application was passed on we frequently found that our counters were congested and the applicants were standing eight or ten deep. With this condition in mind I think that the most striking statement in Mr. Blair's article is found in the last few lines:

"The number of new customers who made application was 62,116, or 20 per cent. of all applications received. Of this number 6,509 were required to pay deposits. This number is equal to 10½ per cent. of all new consumers who made application during the year. The number of deposits taken was 2⅖ per cent. of all applications received."

Our records showed that nearly 98 per cent. of all our applicants are entitled to immediate service without making a deposit, so we asked ourselves, why keep 100 people waiting while we looked up their credit in order to protect ourselves against 2 per cent.

Mr. P. L. King (San Antonio, Tex.): I would like to ask Mr. Blair if they have any trouble about guarantors. Do you ever sue a guarantor for an account that he has guaranteed, and what success do you have in getting payment when you sue?

Mr. Blair: As I said in the paper, the guarantee class are a peculiar class to handle. They are very willing to guarantee, but when the other fellow defaults and the shoe is on the other foot, it is different. If the amount involved is very large, we would not hesitate to file suit, but it is unusual for a few dollars. We have a case on now where a very wealthy man guaranteed a bill, but the lady for whom he guaranteed the bill has defaulted and now he is side-stepping the issue. With the guarantee class, as a rule if they have to pay, it leaves a bad taste in the guarantor's mouth.

Mr. F. M. James (Aurora, Ill.): I think one point that Mr. Blair made in his paper, concerning the interchange of credit information between gas companies could be used to great advantage, and if it is in order I would suggest that this

Section through the Institute Directors take up the matter of formulating some plan for perfecting that ready interchange of credit information, thus insuring the Institute's co-operation.

MR. COHN: I would like to ask what is the plan of sending a check or money in returning a deposit to the customer when his credit is established?

MR. REINACH: In answer to Mr. Cohn's question, we do not require the customer to call at the office to get his money back, we give him the option of either calling at the office or we will mail him a money order for the amount of his deposit or we will send a representative to his residence to refund the amount.

MR. BLAIR: I would like to ask a question. Do you issue a certificate of deposit to the customer?

MR. REINACH: Yes.

MR. BLAIR: Are you supposed to get it back before you pay the money?

MR. REINACH: Yes. We ask for the deposit receipt, but if he has lost the deposit receipt we make out a refund voucher.

MR. BLAIR: Or an affidavit? Do you take an affidavit covering the return?

MR. REINACH: Not an affidavit. The amounts generally are too small to take an affidavit.

MR. BLAIR: It seems to me that you would pay back deposits. Without a certificate you would have trouble.

MR. REINACH: We have very little trouble in that respect. As a general rule, however, we get the depositor's receipt. When he claims he has lost his deposit receipt and can give us evidence that he is the right party, we refund without affidavit. We used to take affidavits, years ago, but we have found that in 5 years we had about three deposits to refund twice.

MR. WILLIAM F. DOOLITTLE (Chicago): I should like to ask Mr. Blair what becomes of money deposited by customers who move from the city and leave an unpaid final bill which equals, exceeds or is less than the amount of deposit? How are these accounts handled in the Bookkeeping Department? What percentage of your total number of customers are delinquent each month? Do you find that as a rule the delinquents are habitually delinquent or are the majority new ones? Do you think that since The Peoples Gas Light & Coke Company has adopted the policy of allowing each customer one discount within a calendar year, delinquent bills and expensive calls of collectors have been decreased? Do you allow discounts on final bills?

MR. BLAIR: I have already answered the first question. We make every effort we can to pay the money back and the times that we are not successful in locating the party and the bill exceeds the deposit we give a credit for the amount; if the deposit exceeds the amount of the bill, we carry a credit balance, expecting that the party will come in some day and get it.

In handling the accounts in the Bookkeeping Department, that is practically answered by what I have already said. The account is carried either with a credit or debit balance.

The percentage of delinquents we find runs from 8 to 13 per cent., according to the territory. It would average possibly between 10 and 11 throughout the entire city.

The question about habitual delinquents. They are constantly changing, but a great many are habitual.

The allowing of discounts. It seems to me that any lax system has a natural tendency to create delinquents.

As to allowing discounts on final bills, we do, where it is necessary to induce settlement.

THE CHAIRMAN: We have two written discussions on this paper, one by Mr. Doolittle and one by Mr. Roberts.

MR. WILLIAM F. DOOLITTLE (Chicago): (Written discussion communicated.) Mr. Blair's paper conveys to us very perspicuously and concisely, the necessity for courtesy and cooperation between credit men in all lines of business throughout the country and more especially in our own line—the gas business.

The credit system in operation by The Peoples Gas Light & Coke Company, Chicago, is in my opinion, a good and efficient one. Good, because it is not too complex; efficient, because it produces results. I have been in the employ of that company for 20 years and have had opportunities to observe its progressive policies in this particular and have seen a gradual annual decrease in the number and amount of outstanding bills, notwithstanding the large increase in number of customers.

Any credit system, whether in use by a large or small company must be simple in its detail to be effective. Complicated routines entangle accounts in red tape and entail loss of time and money. If an account is past due, there is but one logical thing to do; that is to make the collection and make it as quickly as possible.

Gas companies, as a rule, extend credit for one month to nearly all of their customers. Bills should be rendered and accounts made payable as soon as possible after meters are read. Prepayment meters are, of course, the exception to this rule.

In large cities where the population is cosmopolitan and migratory, I believe it would be advisable to increase the force of collectors in those districts where transients usually locate, so that collections may be forced immediately, or, before the "fly-by-night" has an opportunity to increase an indebtedness that he may have no intention of paying. I do not mean by this that the total force of collectors should be increased, but, that a sufficient number could be transferred from the higher class districts for a short time—say one or two days to make calls on all delinquents in districts where the risk is greater, the day after, or the second day after bills are due. That would be concentrating the greatest effort where it is needed the most and would probably reduce this class of losses to some extent.

It may be contended that deposits are required to cover payment of bills in such cases as those to which I have just referred. This is quite true, but if the collector does not call until the 10th or 12th day after the bill is due, the consumption of gas up to that time may exceed the amount of deposit. During the winter months, if the weather is cold, customers frequently use gas for heating purposes, thereby increasing their bills to such large amounts that deposits do not nearly cover one month's consumption.

Accounts should be carefully watched in the winter season and frequent meter readings taken where necessary.

In the paper that has just been read, we are informed that in the year 1915, 45 per cent. of all applications for gas received by The Peoples Gas Light & Coke Company, were received by telephone and 26 per cent. at branch stores. These figures in themselves are a convincing argument that simple and expeditious credit methods are essential if our credit departments are to keep up with the pace set by other departments in giving service to customers. Credit is service.

As I am connected with the Application Department, I shall endeavor to confine my discussion to the relations between that department and the Credit Department, and it will be my purpose to show how the Application Department may be of assistance to the Credit Department, in frustrating the efforts of a tyro, or an old offender, to beat the gas company.

I trust you will not consider it a digression from the subject, if I describe for you briefly a part of the filing system in the Application Department, for this is what enables us to be of aid to our brother employees in the Credit Department.

We have a card record of every service pipe or curb service pipe in the city and an individual card record of every meter set, whether in use or not in use. Service record cards are used in conjunction with meter record cards but as the service records have little if anything to do with credits, further reference to them here would be superfluous.

Meter record cards are kept in steel drawers in a steel cabinet. References to file and entries on cards are made by women employees. There are eight file clerks responsible for these records, each having charge of about 75,000 cards.

When a meter is set or gas turned on where a meter has already been set, a card is printed by the addressograph machines, the machines which are used to print customers names and addresses on gas bills each month. In addition to the name and address, the ledger number and folio is also printed. Meter numbers or sizes are not printed on the card for the reason that when the type is set up it is used first for the card record, then permanently for all monthly bills rendered and it is not considered necessary to show the meter number or size on the bills. Therefore, the meter number and size and the date set or turned on are entered in long hand by clerks in the Application Department.

Each application for gas with its accompanying work ticket is sent to the Application Department, where both are time stamped, then given a serial number and sent to the meter record file. When they reach this file reference is made to the cards referred to heretofore, for the purpose of ascertaining if a meter has been set. If the meter has been set, the application and work ticket are rubber stamped with the words "Turn on". If no meter has been set the rubber stamp "Set" is used and the work ticket sent to the district shop or to the turn-on department for execution, as the case may be.

Now, here is where we assist the Credit Department.

If a meter is shut off for non-payment of bills, non-payment of deposit, refusal to sign application, or, for any reason deemed sufficient to warrant such action by the Credit Department, an entry is made on the meter record card the morning following the date of shut-off. The card entry is made with a rubber stamp which shows the letters C. O. C. D. followed by the date. These letters are the code for Cut-Off by Credit Department. When an application is received from a *bona fide* new customer, or from the same customer whose meter has been shut off and who uses a fictitious name or from some relative or any unscrupulous person who endeavors to beat the company out of the amount due or evade the payment of a deposit by making application for the customer who still resides on the same premises, the application cannot pass the meter record file. Those letters C. O. C. D. stand out on the card as clearly as a mantle light does in comparison with a flat-flame burner.

What is the result?

The application whether signed by an honest or dishonest person is apprehended and sent to the Credit Department for investigation before the meter is turned on. If investigation warrants that the meter be turned on the application is returned marked "O. K. Credit Department." If not O. K. the application is so marked and it is held in a pending file and all inquiries with regard to completing the order are referred to the Credit Department.

Thus you see that this system although simple in its operation, is a safeguard against loss to the company. The meter record files are the outposts and the trenches, for the Credit Department and we keep them well protected at all times.

Before passing on to Credit extended when appliances are sold, it seems timely to inform you that red locks are used when a meter is shut off by the Credit Department and black locks when the meter is cut off by the regular shut-off man; red locks are not replaced with black locks until ten days have expired. This gives the customer an opportunity to pay the bill and have the meter turned on by the Credit Department. Under these circumstances the account remains open on the ledger, but when the black lock is placed on the meter the account is closed and a final bill rendered.

No employees (Credit Department excepted) are permitted to turn on a red-locked meter without first calling the main office for instructions. This prevents the customer from purposely giving the wrong floor when making application and asking the man to turn on the meter for the correct floor when he arrives on the premises. The man doesn't dare to, that red lock forbids him.

Fuel and Illuminating appliance leases, *viz*: Orders for gas ranges, water heaters, arc lamps, etc., which aggregate more than $50.00 are referred to the Credit Department for investigation. As these leases are all sent to the Application Department before the appliance is delivered, there is small chance for the purchaser of an appliance to receive more credit than conditions warrant. It is sometimes considered advisable to demand an increased first payment.

MR. F. MORGAN ROBERTS (Chicago): In the preceding papers, rules and systems have been given precedence; both Mr. Blair and Mr. Doolittle have touched only lightly on the personal equation. Credit systems have been improved, but we are still dealing with the same old human race with their frailities, foibles and other failings. Unpaid bills are a result of three general conditions, penury, indifference and dishonesty. Often, two or all three of these characteristics are embodied in the make-up of your debtor. "The poor ye have always with ye," the Good Book says and well we know it. They deserve all the consideration that can be given them, only care should be taken to keep them within the proper bounds for there is a tendency to take advantage of leniency. Our arrangement in handling consumers' accounts is such that bills do not reach the collectors for attention until after the expiration of the discount date. This is some time after the meter has been read, usually over 20 days. Under our system of handling credits and collections, the customer can make a personal appeal to the superintendent of the department or his assistants, when such customer believes his case is not being properly handled by the credit investigator or collector. It is taken for granted those who are making a fight against poverty intend to pay their bills, but for the time being at least they are in straightened circumstances and want further indulgence. If their accounts and their appeals have any merit, further time is usually given them. However, this is a dangerous ground for you can build up most unprofitable business in this line besides making ineffectual your collector's efforts if it is not carefully handled.

A patron who is able to pay but who is indifferent as to when he does so, and who thinks this ability to pay is sufficient to shield him from a collector's attention is one of your worst trouble-makers. Naturally it is not necessary to annoy a good customer by the unwelcome attentions of the collector, but this class which is delinquent each month and often run two or three before they settle should be impressed with the importance of prompt payment for it is the essence of all credit. It is a fact that some of these people think that prompt payment is not of consequence. This wrong impression should be corrected whenever it is found to exist, for there is still prevalent an idea that a large corporation can wait for its money. We find this to be so in discussing cases with many of our customers. We also learn that all their other debts are paid such as the butcher bill, grocery bill and rent bill, but the gas bill has been overlooked intentionally.

Now, if we allow our debtors to think it is immaterial as to when they pay their bills and that prompt payment is not desirable, it will have the most demoralizing effect in our future business. When these people take their cases up at the office and express their exceptions to the collector's efforts to collect unpaid bills, they should be given to understand as courteously as possible the unnecessary annoyance they are creating for themselves also the loss they are sustaining in forfeiting their discounts monthly, and in addition the expense they are making for the company that we would be glad to eliminate.

Your dishonest customer who deliberately sets himself out to beat you, is fortunately only a small percentage of the whole, and as a general rule he succeeds in getting you, for that is his business, and in this class there is a type who will pay only until the opportunity affords and then take advantage; their number is our regret. It was for these that our Credit System was devised.

You can make all the rules and regulations you wish to regarding your credit business but these know the game of duplicity and evasion better than you do, and will circumvent you when the proper time comes. The cases developed by this class we are all familiar with; they stand out so glaringly in their effrontery and brazenness.

Our business is peculiar in this respect that we are not in a position to immediately curtail our service should we see fit to do so. The gas is on tap and can be used *ad libitum.* We are often not in a position to even refuse further service when we think a delinquent patron has created a greater indebtedness than we deem consistent with good business practice, as we cannot cut off gas if the meter is not accessible and we are refused access to the premises. Eventually our only recourse is process of law, a replevin suit to recover our meter.

Cosmopolitan as our city is, there are hardly any definite lines to mark the good and bad territories. A street like Halsted Street is an instance covering as it does a number of miles and strewn with every class of humanity. Some sections show distinctive races with all their traits and peculiarities; others a blending of the whole; and, again, there are blocks that boast of aristocracy. Under our system of collecting, our disposition of collectors in their respective divisions is so elastic that any number could be thrown in any given territory any time we should so desire. For collection of our regular bills, the city is divided into twenty-one districts, each having a special discount date and the arrangement for collection of final bills is quite similar.

Paradoxical as it would seem, the people who live in the cheaper sections of the city and are of small means give us the least trouble. They usually pay promptly for it is a matter of thrift with them and they become delinquent only through stress of circumstances. Unless such customers become calloused by their misfortune, payment is eventually made and not studiously evaded; but if you permit a large indebtedness you are to an extent placing a premium on a poor man's dishonesty, for the temptation will be greater for him to evade the bill, if it is of goodly size than if it were a small one.

Mr. Doolittle's suggestion that we take frequent readings of the meters of a certain class of customers who may use gas for heating is not practical. This is a development we are not aware of until it is too late. Unfortunately for us most of these cases are where the meters are not accessible without going into the occupant's premises, namely, the basement, if it is a residence, or the bathroom, if a flat and in such cases you are going up against a man's fortress if he is not willing to admit you.

We do have a system of reading meters weekly, but this generally applies to business accounts where the bills run large, and we know from the results of our credit investigations that the account is liable to be a poor one. This arrangement is most advantageous not only to ourselves but to the customer, for it keeps bills down to the minimum, and prevents a large indebtedness should the gas be cut off for non-payment. Besides, it gives us the opportunity to assist the customer to the extent of cutting down the required deposit just to one-fourth of what it would be on a monthly basis.

Guarantees have been mentioned in lieu of deposits, but I say, beware of guarantees. You will find they are most readily tendered, but difficult to collect. Even if you are successful in forcing collection from the guarantor you have made in him a disgruntled customer. I have never yet seen a guaranteed bill paid with good grace, and, therefore, make it a point whenever they are taken to carefully explain to the prospective guarantor his obligations, and to impress upon him that he is assuming a risk that we do not care to handle. Our guarantees generally cover the small household accounts, but we are skeptical about them when they are tendered to cover a business proposition where the bills run large.

MR. LOHMEYER: I want to ask Mr. Blair one question, as to whether he runs into any legal difficulty in cutting off a customer after once turning on the service just because his credit information is not what he feels it should be?

MR. BLAIR: No. Our applications read "that at a stated time certain sums of money can be called for to secure the payment of bills if necessary." We rarely have any trouble about cutting off after it is turned on.

MR. PURCELL: You stated that 45 per cent. of your applications were received by 'phone; suppose some of them develop bad credit after being turned on?

MR. BLAIR: We serve the customers notice as outlined in that paper and the supply of gas is discontinued if necessary.

We make the investigation and determine the status of the account and act accordingly.

THE CHAIRMAN: We are greatly indebted to Mr. Blair for an excellent paper that I think will prove of great value, it is on a live topic that we all have to deal with and it is troublesome, too.

Mr. James suggested that the Credit Departments of the companies should co-operate—that is the idea, was it not? Do you care to put that in the form of a resolution, or was that more for the record?

MR. JAMES: It was my idea to have the directors or whoever have the control of this Section take the matter up. It was my thought, if the Institute could co-operate with the credit man to that extent and formulate some plan for the ready interchange of credit information, concerning customers who move from one city to another.

THE CHAIRMAN: I think that will cover it very well, and the incoming administration can take the matter up. I think your suggestion is a very important one. I do not see any reason why gas companies should not co-operate and co-operate thoroughly in this matter of credits.

MR. REINACH: The Consolidated Gas Company, of New York, has used these reference slips to great advantage; they have been sent to different companies in the country and they have returned them to us. These reference slips are gummed so that when they are returned they can be pasted on the back of the application as a record. We should be very pleased to send samples to those who wish to have them.

MR. R. L. DEZENDORF (New York.): I am indirectly int rested in this paper because sometimes the cutting off of a very bad delinquent is referred to the department that I represent. I want to ask if the Peoples Gas Light & Coke Company have the assistance of the local authorities on their co-operation to any extent, or whether the cutting off of a bad consumer is a matter of strategy?

Mr. Blair: If payment is not made by a certain date the gas is shut off. In the majority of cases we shut them off without any trouble; if they try to keep us out we have to use a little strategy, we usually get a man and deck him out in a Gas Inspector's uniform and send him to execute the cut-off.

The Chairman: Does that answer the question?

Mr. Dezendorf: Yes.

Mr. Reinach: I move that we adjourn.

On motion duly made and seconded, the meeting adjourned.

CHEMICAL SECTION.

First Session, Thursday A. M., October, 1916.

MR. R. B. HARPER, *Vice-President*, presiding.

MR. LOUIS J. BECKER (Chicago), *Secretary*.

THE CHAIRMAN: The Chemical Section will please come to order. Mr. J. W. Shaeffer's paper, "The Equivalent of the Observed Heat Value of the Light Oil Scrubbed from Coke Oven Gases," is the first on the program.

THE EQUIVALENT OF THE OBSERVED HEAT VALUE OF THE LIGHT OIL SCRUBBED FROM COKE OVEN GASES.

In preparing this paper, inquiries were sent to thirty by-product coke plants throughout the country which manufacture nearly one-half of the total by-product coke oven gas in the United States. These thirty plants include the various types of ovens and many different kinds of coal, so that this information is thought to be representative of the coking practice at the present time in this country.

THE HEAT EQUIVALENT.

The results of the inquiry have shown that the loss in B. t. u. of the gas as shown by calorimeter tests due to scrubbing out the light oil is only slightly greater than the heat value of the light oil removed. For these calculations the heating value of light oil was determined by calorimeter tests and found to be 17,400 B. t. u. per pound of liquid light oil. To this was added the latent heat of vaporization of benzol, 167 B. t. u. per pound, as calculated from Smithsonian Physical Table No. 234. The heating value of the light oil plus the latent heat of vaporization gives 17,567 B. t. u. for the gross heating value per pound of light oil vapor. This value is considerably lower than the corresponding value for pure benzol, which is 18,793. This is accounted for by the presence of carbon disulphide and other impurities, which have a comparatively low heat value. The latent heat is added in order to make the calculations comparable with calorimeter tests in which the light oil enters the calorimeter in the form of a vapor.

In determining the actual loss in heating value due to scrubbing out the light oil, calorimeter tests were made in the usual way on the gas before and after the scrubbers. The difference in B. t. u. divided by the B. t. u. of the gas before the scrubbers gives the percentage of actual loss. The calorimeter tests are understood to be the gross B. t. u. values.

The B. t. u. per cubic foot of the gas after the scrubbers was calculated as follows:

$$\frac{a - 121{,}827b}{1 - 35b}$$

Where a = The B. t. u. per cubic foot of the gas before scrubbing.

b = The gallons of light oil removed per cubic foot of gas.

35 = The cubic feet of vapor per gallon of light oil.

The constant 121,827 is the product of 17,567, the B. t. u. per pound of light oil; 7.3, the pounds per gallon of light oil, and 0.95, a correction factor correcting for the amount of absorbing oil in the light oil. The amount of absorbing oil is assumed to be 5 per cent. This figure varies considerably under various operating conditions, one plant reporting as high as 10 per cent., while others have only 4.

The average of all calculations shows a theoretical loss of 4.45 per cent. while the actual loss as determined by calorimeter tests at these same plants is 4.62 per cent.

For a plant where the light oil is removed with a fair degree of completeness, these figures will be considerably higher, about 5.8 per cent. The above averages are low on account of their including plants which were scrubbing with a comparatively low efficiency.

THEORY VS. PRACTICE.

These figures have shown that the actual and theoretical losses agree within the limits of probable error in calculation and determination. In contradiction to these facts is the belief of many gas engineers that the actual loss due to scrubbing out the light oil is much greater than the calculated loss.

This belief is based on observations rather than on tests or calculations. The observed loss due to scrubbing the light oil out of the gas is likely to be considerably greater than the actual loss. This high observed loss is due principally to two causes. *First*: In practice only the net heating value of the light oil vapor is utilized, the moisture which is formed escaping in the form of a vapor in practically every instance where gas is used. *Second*: The opinion by observation is likely to be formed as soon as the light oil recovery plant is put in operation and before the readjustment of the air supply to the burners has been made.

In the accompanying table an analysis of by-product coke oven fuel gas is given, showing the amount of air required for combustion, the amount of heat liberated and other data. It will be noticed that benzene occupies only 1.1 per cent. by volume of the original gas, but that it furnishes 7.4 per cent. of the total heat which is liberated when the gas is burned; also that this 1.1 per cent. of benzene requires 8 per cent. of the total air which is required for combustion. It follows from this that if the light oil be removed from the gas by scrubbing, then until the air supply to the burners has been readjusted, the heating will be affected in two ways: (*a*) the loss of nearly 7.4 per cent. in calorific value, and (*b*) burning with an excess of nearly 8 per cent. of air. This lowers the flame temperature and gives the appearance of a gas of a much lower heating value.

One interesting fact, which may be confirmed by a few simple calculations, is that the percentage decrease in flame temperature due to removing the light oil is less than the percentage decrease in its calorific power, provided the air supply to the burners is properly adjusted. This is true because the flame temperature of light oil vapor is somewhat less than the proportional average of the other constituents in the gas.

TABLE SHOWING GAS ANALYSES, AMOUNT OF AIR REQUIRED FOR COMBUSTION, AMOUNT OF HEAT GENERATED, ETC.

Analysis per cent. by volume		Required for combustion				Products of combustion			Amount of heat	
Before scrubbing		O_2	N_2	Air	Per cent. of total air	CO_2	H_2O	N_2	B. t. u.	Per cent. of total
CO_2	1.7	0.000	0.000	0.000	000.0	0.017	0.000	0.000	0	0.0
C_6H_6	1.1	0.082	0.312	0.394	008.0	0.066	0.033	0.312	41	7.4
C_2H_4	2.0	0.060	0.227	0.287	005.9	0.040	0.040	0.227	31	5.6
O_2	0.5	—0.005	—0.019	—0.024	—000.5	0.000	0.000	—0.019	0	0.0
CO	5.8	0.029	0.109	0.138	002.8	0.058	0.000	0.109	18	3.3
CH_4	30.0	0.600	2.268	2.868	058.5	0.300	0.600	2.268	297	53.7
H_2	52.0	0.260	0.983	1.243	025.3	0.000	0.520	0.983	166	30.0
N_2	6.9	0.000	0.000	0.000	000.0	0.000	0.000	0.069	0	0.0
Total	100.0	1.026	3.880	4.906	100.0	0.481	1.193	3.949	553	100.0
After scrubbing										
CO_2	1.7	0.000	0.000	0.000	000.0	0.017	0.000	0.000	0	0.0
C_6H_6	0.1	0.007	0.028	0.035	000.8	0.006	0.003	0.028	4	0.8
C_2H_4	2.0	0.060	0.227	0.287	006.2	0.040	0.040	0.227	31	5.9
O_2	0.5	—0.005	—0.019	—0.024	000.5	0.000	0.000	0.019	0	0.0
CO	5.9	0.029	0.111	0.141	003.1	0.059	0.000	0.111	19	3.6
CH_4	30.3	0.606	2.291	2.897	063.1	0.303	0.606	2.291	300	57.5
H_2	52.5	0.263	0.992	1.255	027.3	0.000	0.525	0.992	168	32.2
N_2	7.0	0.000	0.000	0.000	000.0	0.000	0.000	0.070	0	0.0
Total	100.0	0.960	3.630	4.591	100.0	0.425	1.174	3.707	522	100.0

This table shows the analysis of coke oven gas before and after scrubbing. Some coke oven plants are producing an unseparated gas much richer than the one shown while others produce a gas of considerably poorer quality. The analysis does not represent an average of any number of plants. It is selected only as an example. The table is based on the volumetric relation which exists between the gas, the air which is required for its combustion and the products which are formed during combustion. The figures refer to 1 cubic foot of the gas under standard conditions.

CONCLUSIONS.

1. The actual loss in the gross calorific value of the gas due to the removal of light oil is about 5.8 per cent. at plants when the removal takes place with a fair degree of completeness.

2. The theoretical loss is practically the same as the actual loss. This is an average determination.

3. Some plants show a greater actual loss than the theoretical loss and some *vice versa;* all agree within the limits of probable error in determination.

4. The observed loss due to the removal of the light oil is considerably greater than the actual loss. This is accounted for by the difference between the gross and net heating values and an improper adjustment of the air supply to the burners.

5. The observed loss has led many gas engineers to believe that the actual loss is greater than it really is.

6. The true value of light oil in a gas lies in its effectiveness per unit volume. One and one-tenth per cent. of light oil by volume furnishing 7.4 per cent. of the total heat, which is formed when the gas is burned.

MR. C. J. RAMSBURG (Pittsburgh): I am surprised that Mr. Shaeffer is not here, as I know he expected to attend and take up the discussion of this paper.

It seems to me this paper has covered the ground extremely well and practically exhausted the subject. There is no doubt but that the gas industry is entering an era that will make conditions entirely different from those of the past. It is going to be a matter of humiliation to the gas industry of the next 5 or 6 years to recall the fact that most of the gas sent out in this country was sent out containing a composite hydrocarbon vapor and that this gas was saturated with this hydrocarbon vapor when it left the plant and deposited the hydrocarbon in the street mains throughout the system.

With the introduction of the B. t. u. standard, it seems to me that the gas business will find it necessary to conserve the lighting business and necessary to conserve their profits, to send out a gas which is saturated with hydrocarbon vapors only to that point at which there is going to be no condensation in the street mains. It may be that all hydrocarbon vapors will be removed from the gas, and in fact this will probably be so in both coal and water gas.

This paper comes in then in a very formal way as showing the very small loss in B. t. u. value by removing the benzol constituents from the gas entirely.

MR. E. C. JONES (San Francisco): Our first experience with high-pressure distribution of gas brought us to the same conclusion as that of the author of this paper. In compressing gas we squeeze out the more unstable hydrocarbons, including the benzene. Away back in the early days of high-pressure gas distribution we began to realize the benefits of stability in gas. On the high pressure systems covering gas free from condensable hydrocarbons there were no naphthalene troubles nor other complaints frequent in low-pressure systems, and the gas man's life was comparatively happy.

In 1906 I conceived the idea of subjecting the oil gas made on the Pacific Coast to compression from atmosphere to 300 pounds to the square inch for the purpose of obtaining data to be included in a paper on the Effects of Compression on Illuminating Gas for the first meeting (1906) of the American Gas Institute.

I found that the actual heating value of the gas suffered very little by compression, while the candle-power suffered considerably. It, of course, seems unreasonable to squeeze out from the gas hydrocarbons having a theoretical heating value of from 2,000 to 4,000 B. t. u. per cubic foot, without reducing the heating value of the gas; but I find that these hydrocarbons cannot be consumed efficiently in gas appliances nor can their calorific value be realized in a Junkers calorimeter, which may be considered as merely an efficient appliance for heating water.

We must also consider the much greater amount of air necessary for the combustion of hydrocarbons and the waste of heat necessary to raise the attending nitrogen to the flame temperature of the gas. The washing of unstable hydrocarbons from gas seems like taking something away from it, but the gas men of the future will realize that it is adding to the value of the gas commercially.

CAPT. W. E. MCKAY: We are indebted to Mr. Shaeffer for the preparation of this paper, which he undertook somewhat late in the year, in consequence of a defection of part of the program that had been arranged for.

We are interested particularly in the way he has presented the matter and he has from one point of view thoroughly covered it, but there is also another point of view in relation to this whole subject.

Our company operates as one of its plants a by-product plant of which the surplus gas is sold at approximately 29 cents per 1,000 cubic feet, so that any reduction of this surplus rich gas is closely scrutinized. For many years we have been considering the installation of a plant for the removal of the light oils from the lean gas and had always been strongly influenced in our decision by the reduction that might be expected in the amount of surplus gas after we had taken the light oils out of the lean gas fraction, such reduction consequent upon the reduction in the heating effect, not alone the heating value. Mr. Shaeffer deals with the heating value. The heating effect is reduced very much more than the heating value.

Our examinations agree almost exactly with the figures stated by Mr. Shaeffer, so far as the theoretical value of the benzol vapors is concerned. On page 516 Mr. Shaeffer says: "In contradiction to these facts is the belief of many gas engineers that the actual loss due to scrubbing out the light oil is much greater than the calculated loss. This belief is based on observations rather than on tests." We are unfortunately in the position of knowing by observation that the loss of surplus rich gas is very much greater than would correspond to the reduction in the heat value of the fuel gas by the removal of light oils.

In his conclusion Mr. Shaeffer states that this is accounted for by the difference between the gross and net heating values. He is now speaking, however, on the heating value of the gas, but that will not explain the reduction of the heating effect.

In one plant, not our own, the B. t. u. loss in the gas agreed very closely with this as stated in Mr. Shaeffer's paper, but the reduction in the surplus gas available per ton of coal amounted to 48,000 B. t. u. per gallon of light oil, which is so very far in excess of the theory, something over three times the theoretical loss to be expected, that we must look in some other direction for a full explanation of such a reduction, and our own experience is quite in accord with this extraordinary and unexpected result. We have tested our reduction of surplus rich gas per ton of coal by measurements of surplus rich gas prior to putting the light oil plant into use, and then with the light oil plant in use; that is to say, making the adjustment from not using the light oil plant to using the light oil plant. Then we have tested it repeatedly the other way, with the light oil plant in operation and then discontinuing the operation and observing the recoverable surplus rich gas per ton of coal, and in each instance the loss in heating effect has been very much in excess of anything that might have been anticipated from the theory or from the observed reduction in the heating value of the gas itself.

MR. C. J. RAMSBURG: From Capt. McKay's remarks in regard to the difference between the theoretical and the actual loss, I think that you are apt to get a misconception of the absolute conditions except in perhaps his plant and his type of plant.

At the Laclede Gas Plant and a great many of the by-product plants, where they are now taking out the benzol from the lean gas, the gas is all actually measured and calorimeter readings made daily, and the amount of B. t. u. necessary to coke a pound of coal is at hand, giving, for instance, at the Laclede plant the number of B. t. u. necessary to coke a pound of coal before and after the benzol was removed from the gas—because I am quite afraid that this effect does not take place in by-products.

Mr. L. J. Willien, Jr. (Boston): I would like to ask whether the coke oven from which this information was obtained stripped only the lean gas, that is, the gas used for heating furnaces, or whether it has taken into account the rich gas. In that case, I imagine that the loss would be somewhat greater.

I made some tests on stripping mixed coal and water gas containing a large percentage of water gas and obtained a drop in the heating value of about 7½ per cent.

Mr. A. C. Wilke (Milwaukee): I think they scrub the entire gas; all the gas made there now is scrubbed.

The Chairman: The paper is bringing out a good discussion. Is there anybody else that would add anything?

Mr. Ramsburg: May I ask Capt. McKay if he has any explanation of the phenomenon. What becomes of the heat? Is it due to the character of the flame? Does it go out in the process of combustion?

Capt. McKay: All these questions which Mr. Ramsburg has asked are pertinent. We do believe that it concerns itself with the character of the flame, as Mr. Ramsburg has implied, without saying so distinctly. Our own plant is one of the oldest and possibly one of the least efficient by-product coke plants in the country, but the question of the actual loss is still pertinent, and in seeking a reason for this great discrepancy between what we would expect and what we actually know, we observed to give the best possible operations we have finally fallen back upon the explanation, however unsatisfactory and incomplete it may be, that it is chiefly due to the character of the flame.

MR. RAMSBURG: What I wanted to bring out was the fact that this was a particular case and not a general situation, and that while it was interesting and should be followed up and carried through to conclusion, that it should not leave the impression that for instance after removing the benzols from water gas or coal gas that the efficiency of the gas stove was going to fall off in the same manner, or that anything of that kind would happen.

CAPT. MCKAY: On the contrary, it ought to be the other way.

MR. RAMSBURG: It ought to be the other way and I wanted to correct that possible impression.

CAPT. MCKAY: In entire combustion you would have different conditions—different conditions that would keep your flame under control; with a heating temperature surrounding it you would have an entirely different condition.

No, I very much regret the imputation or any deduction from my statement that it would seem to show that the removal of those bodies from the gas being tested for general use would be other than to its improvement.

MR. A. B. WAY (Everett, Mass.): I move that we express our appreciation to Mr. Shaeffer for this paper which has been so interesting, and that a vote of thanks be extended to him.

(Motion seconded and unanimously carried.)

THE CHAIRMAN: The next paper is the Removal of Sulphur from Spent Oxide, by Mr. Edward J. Murphy. I believe Mr. Murphy is not here, so I will ask the Secretary to read the paper.

THE REMOVAL OF SULPHUR FROM SPENT OXIDE.

In the utilization of by-products obtained from the manufacture of gas, practically all of them have come into some use except spent purification oxide. This material is considered in general to be a waste product and having done the required work, is thrown on the refuse heap especially that used in carbureted water gas purification. While the costs involved in gas purification are not the largest in gas manufacture, it nevertheless occurred to the writer, that if the free sulphur in spent oxide could be removed economically it could be used again for purification purposes, instead of being thrown away.

It has been shown by Pelouze[1] that distillates from coal tar dissolve considerable amounts of sulphur at a temperature approaching their boiling points, while at ordinary temperatures only a small percentage is dissolved. The absorption of sulphur occurs notably with the heavy oil distillates (200°-300° C.). Recently a patent was obtained in France for the extraction of sulphur and nitrogen from spent oxide.[2] In this process the patentees use coal-tar distillate heated to 100° C., the minimum boiling point of the oil used being somewhat higher.

As water gas tar was all that was available to the writer it became necessary to determine whether distillates of this type had the same property of dissolving sulphur. Accordingly a large sample of water-gas tar was distilled up to 225° C. and then redistilled and cut at the following temperatures above 150° C.

Temperature °C.	Specific gravity at 20° C.
150–160	0.8692
160–170	0.8743
170–180	0.8843
180–190	0.9023
190–200	0.9145

Each of these fractions was then treated with an excess of pure sulphur and slowly cooled to 20° C. The sulphur crystallizing out, was filtered off and that remaining in solution was determined.

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[1] Pelouze M. E., *Comptes Rendus*, vol. 68, pp. 1179–80; vol. 69, pp. 56–57.

[2] *Journal of Gas Lighting*, vol. 125, p. 29.

TABLE SHOWING SOLUBILITY OF SULPHUR AT 20° C.

Distillate °C.	Grams sulphur in 100 cc. distillate at 20° C.
150–160	2.60
160–170	2.69
170–180	2.80
180–190	2.94
190–200	3.33
150–200	2.74

These results are almost identical with those of Pelouze, who used coal-tar distillates.

Extractions were then made on some of the coarsely ground spent oxide using a Gooch crucible in a Ford-Wiley-Soxhlet extractor, and a paper cartridge to hold the oxide. In order to obtain results that were comparable each sample was extracted for 45 minutes with the distillate. The crucible was then withdrawn and the oxide washed twice with toluene, three times with ether, dried at 105° C. and weighed. The results are tabulated herewith.

Distillate °C.	Per cent. extracted, sulphur and tar	Per cent. sulphur in extracted sample
150–160	53.35	7.40
160–170	54.93	6.98
170–180	55.97	6.30
180–190	56.32	5.92
190–200[1]	56.39	6.11

The original oxide contained 52.15 per cent. total sulphur. Only the result of one extraction with each distillate is shown, as the above sample is a fair average of all that were treated.

For the purpose of showing the performance of an extracted oxide, with respect to its fouling properties, large samples of oxide and correspondingly large amounts of the entire distillate (150°-200° C.) were used. The oxide was first air dried but not ground and the extraction was made in the apparatus shown in Fig. 1. This is a simple tin percolator con-

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[1] As the temperature approaches 200°C., H_2S is very noticeable, due probably to decomposition of the sulphur.

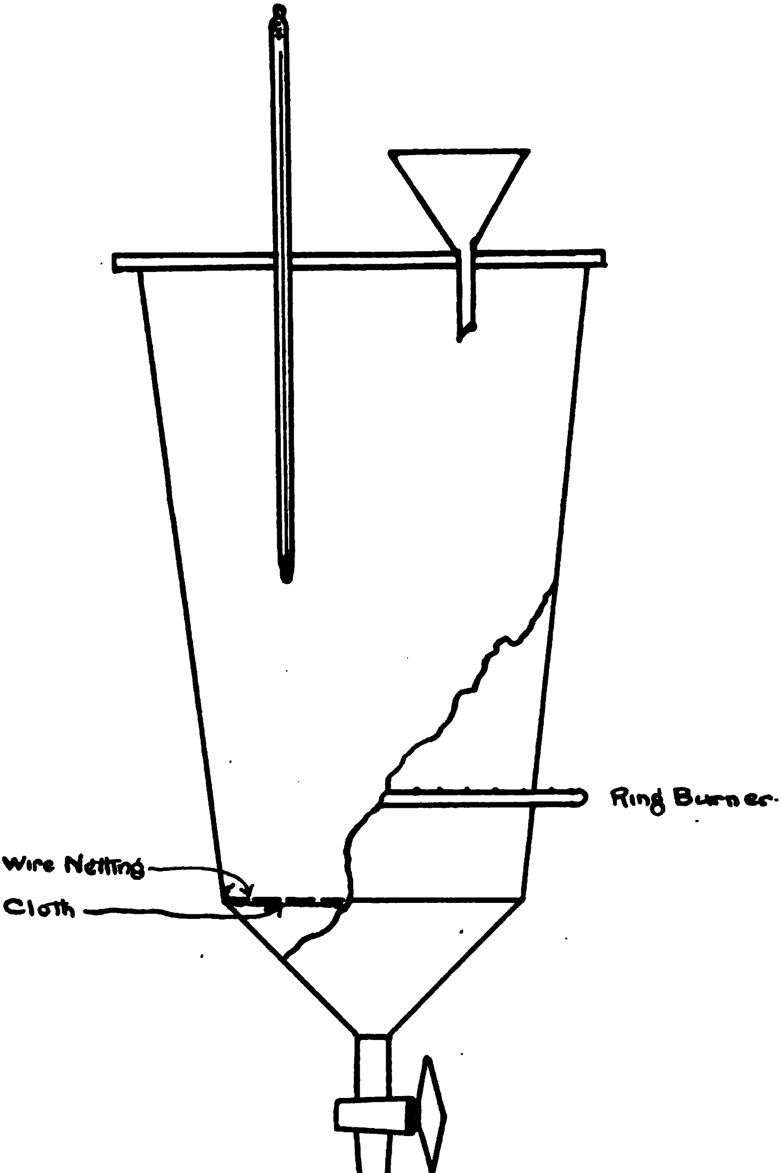


FIG. 1.

taining a fine wire mesh sieve and a piece of muslin, which is necessary to prevent the iron oxide from running through with the oil. The oil and oxide were mixed together and heated to 100° C. and this temperature held for five minutes. The oil was allowed to flow out through a cock at the bottom of the percolator and cooled. After cooling, the extracted sulphur which crystallized out very readily was then filtered. The oil was used again for a second extraction on the same oxide. Each oxide was extracted twice and finally freed from oil by passing slightly warmed air over it. In the results shown below extractions were made with water-gas tar distillate (150°-200° C.) and the fouling tests were done according to the Kunberger method.

Sample	1	2	3	4	5	6
Oxide, grams	100	100	200	500	500	500
Distillate, cc.	300	300	500	1,500	1,500	1,500
Sulphur remaining after extraction per cent.	6.46	6.48	7.11	6.90	7.54	6.26
H_2S Absorption						
Change 1	12.54	15.00	22.43	16.41	18.09	13.51
Change 2	12.79	13.05	20.00	15.12	15.02	13.10
Change 3	14.83	12.01	11.18	11.44	14.02	14.65
Change 4	8.71	10.40	6.27	9.20	11.76	11.21
Change 5	7.86	8.21	4.11	7.41	8.12	7.72
Change 6	8.89	6.46	4.25	5.05	3.04	6.21
Change 7	5.45	4.09	3.61	5.12	2.02	2.86
Change 8	2.11	1.48	0.42	3.12	0.77	1.01
Change 9	1.87	0.63	0.61	3.00	1.12	0.59
Change 10	0.92	0.72	0.33	2.46	0.91	1.19
Total	75.97	72.05	73.21	78.33	74.87	72.05

By the results shown above it can be seen that the avidity for hydrogen sulphide of an oxide after being treated compares favorably with any good oxide. It might be stated here that all the samples treated were precipitated oxides. It is also to be noted that the percentage of unextracted sulphur is a practically constant figure. Just how many times a spent oxide could be treated and used the writer is not ready to state. Lack of time prevented the working out of this important point.

It must be borne in mind that the results given in this paper are all made on a laboratory basis and of course not much can be said, at this time, of the economics of the process. The various costs for apparatus, labor, etc., have to be taken into consideration, but the material necessary for the extraction is to be found right in the works. This can be used over and over again, it is only necessary to redistill the oil when the amount of tar, which is also extracted with the sulphur, becomes troublesome. The writer hopes to be afforded the opportunity to try the process on a working scale, as it is believed to offer possibilities.

This paper is offered as a suggestion for the economical use of a material which at present is of comparatively little value.

In closing the writer wishes to express his thanks to Mr. Joseph Jares for his valuable assistance in performing the above experiments.

THE CHAIRMAN: We will start the discussion with a written discussion by Mr. Seddon.

MR. S. V. SEDDON (Brooklyn, N. Y.): (Written discussion communicated.) I have read Mr. Murphy's very interesting paper and hope that he will be afforded an opportunity to try out the process on a working scale.

His experiments show that spent oxide can be almost entirely freed from its sulphur contents, with no detrimental effect to the oil used, and rendered fit for further purification of gas. It has occurred to me that this process might develop a means by which spent oxide could be revivified *in situ,* using steam coils to heat up the contents of the box. If this proves practical, it will increase the life of the oxide and will represent a saving due to the sale of the sulphur extracted.

In quite a number of plants the oxide is now revivified between changes by drawing air through the mass. This process makes no provision for recovering the sulphur, and is attendant with some danger due to the heating of the mass; and the idea of doing this by means of a liquid in a closed box presents some very advantageous features. The air connections could be still utilized for drying out the oxide after the sulphur had been extracted.

THE CHAIRMAN: We have also a written discussion by Mr. E. C. Uhlig on this paper, which the Secretary will read.

MR. E. C. UHLIG (Brooklyn, N. Y.): (Written discussion communicated.) This paper is very interesting from a scientific point of view, inasmuch as it is shown that the oils from water-gas tar have a solvent effect on sulphur, similar to those from coal tar as shown by Pelouze.

Whether any practical application may be made depends entirely on the cost of purification oxide and of sulphur. While the present cost of oxide is higher than in the past it would hardly seem that there would be any advantage at present in removing the sulphur and selling it. The sulphur thus removed could not compete with that obtained by ordinary means.

MR. W. H. FULWEILER: There are several points in connection with the practical operation of the recovery of sulphur from spent oxide that should require some consideration. The fraction of water-gas tar that he recommends is rather small in some tars and frequently will not reach 10 per cent., so that quite a considerable amount of tar would have to be distilled in order to obtain a sufficient amount of this distillate. Another point is the amount of solvent that is retained by the extracted oxide and is therefore lost. This is a matter of considerable importance, particularly at the present time. I believe that the fraction would be worth nearly 20 cents per gallon and a bushel of oxide would probably soak up a gallon at least, so that the cost of the solvent might easily be more than the value of the oxide.

Another point to be considered is that the sulphur that is recovered, especially from water-gas oxide would probably not be very pure, and it might be difficult to secure a good price for it, owing to the fact that you can buy sulphur with a guarantee of purity of something approximating 99.6 per cent., and therefore, free from all deleterous ingredients for a very reasonable price as I understand they have a five years' supply in stock ready to be sold.

I should like to ask what the Kunberger test was on the oxide before being treated so that we could obtain a more accurate idea as to what effect the treatment had on the purifying efficiency of the oxide. In connection with the heating of oxide some experiments we have made seem to indicate that 100° C. is very close to if it does not exceed the danger line, and I am afraid that on a large scale if they attempt to heat the material to that temperature they would probably seriously effect the purifying efficiency.

Mr. E. C. Jones: I was very much interested in this paper, because it is a step in the right direction; that is, the lengthening of the life of purifying material. I would be just a wee bit afraid of coating the carrying material of iron oxide, the shavings or the sawdust, with any oily substance. I am afraid it would have a destructive effect, and if we should coat it with a film of oil, I am very much afraid it would interfere with the purification effect.

I thought it might be interesting to some of you to know what we are doing in California with the spent oxide running as high as 65 per cent. content of sulphur. The description of it is contained in a paper read before the Pacific Coast Gas Association in San Francisco, by Mr. E. S. Jones, of Sacramento. In our country where agriculture is so important it occurred to him that the sulphur in spent oxide existed in a particularly fine condition; that is, if you can imagine the transformation of sulphur from hydrogen sulphide, talcum powder would be like paving stones compared with it. In California we use large quantities of lime-sulphur solution in our work for dormant and spring spraying of trees, and it is quite expensive; it means a great deal of money to the orchardists. In this intensive agriculture, where we plow our orchards and spray our trees and carefully prune them every year, it costs a lot of time and money to produce fruit without worms, the fruit that is demanded of California. My son took some of the spent oxide and constructed a cylinder in which he placed the oxide, together with a weighed quantity of quick lime, and in this cylinder he had sprays of steam and also had a steam coil; the cylinder was revolved and in a short time lime sulphur of about 22° Baumé flowed from the lower end of the cylinder. This is a readily merchantable product and the mixing of lime with your oxide, if it should be in excess, would very much improve the quality of the oxide instead of being detrimental to it, as any oily matter would be retained in this material. I brought a small sample of the lime-sulphur from California; it is of an orange, or reddish orange color, and is ready for spraying, mixed with ten parts of water to one of the lime sulphur for dormant winter spraying, and one part of this material to thirty-five parts of water for summer spraying. This method of disposing of spent oxide and recovering the oxide fit for re-use, possibly indefinitely, has been handed to the gas fraternity as a possible solution of the question. It is given to the gas fraternity as a means of disposing of what has been and I presume is in many plants a disagreeable and expensive refuse.

THE CHAIRMAN: Mr. Jones has brought out an interesting phase of the subject, and perhaps some one else has something a little different to add, or would like to further discuss the paper.

MR. M. E. MUELLER (New York): I gathered from the written discussion that was read by the Secretary that the suggestion was made to treat the oxide in the purifying boxes without revivification. I would like to bring out that under those conditions the oil would probably not remove the sulphur from the box, from the oxide. There would only be the free sulphur that would be removed by the oil, and not the sulphur in the form of iron sulphide.

MR. C. A. SCHNERR (Chicago): In furtherance of Mr. Jones' remarks in the matter of coating the oxide material with oil, I think that Mr. Murphy speaks of using oil from about 150 to 250° C., and then he speaks of the removal by currents of slightly warmed air. It seems practically impossible to remove traces of very heavy oil of that nature from the purifying mass in that way, and if there is any continuance of this discussion, I would like to know just how Mr. Murphy removed the traces of oil from his oxide mass.

THE CHAIRMAN: Before we attempt to have any questions answered, I would like to know if there are any others that would like to discuss the paper.

MR. L. J. WILLIEN, JR: In connection with Mr. Jones' method of treating oxide. I would like to know if any great amount of lime remains in the material. It has been my experience that where you purify with lime, it does take out a certain amount of hydrogen sulphide to a certain point, but when the lime is all sulphided, the carbon dioxide in the gas will decompose the lime and throw off hydrogen sulphide so that you will have more at the outlet of the boxes than at the inlet.

MR. E. C. JONES: I had no intention of conveying that idea, but I suppose many of you have had the experience of oxide of iron showing an acid reaction while in use, and in this condition it does not act readily as a purifying material.

I find that some of our woods are not suitable to the making of oxide, and we have to avoid the use of California red-wood and others that contain an acid. Oxide of iron should be either neutral or slightly alkaline, and I have known batches of oxide to show an acid reaction after having been in use for some months, and it became necessary to wash the oxide with limewater for the purpose of neutralizing it, and it occurred to me that perhaps adding lime to the oxide would be rather beneficial than harmful.

THE CHAIRMAN: Are there any other points to be brought out? There were a number of questions asked and I wonder if any one would volunteer an answer to them.

PROF. A. H. WHITE (Ann Arbor): The plan of utilizing spent oxide proposed by Mr. Jones is novel and interesting. It is, however, to be noted that he is referring to the oxide as produced in California by the oil gas process which contains very little cyanides. If this process were tried with coal gas oxide it is almost certain that the lime would react and give in solution either cyanides or possibly sulphocyanides. These might improve the properties of the material as an insecticide or they might make it too dangerous for commercial use. It would seem wise, therefore, to have this aspect of the question carefully investigated before an attempt is made to introduce the process in the East.

MR. C. J. RAMSBURG: I would like to add to the discussion of the point that there is going to be in this country a tremendous amount of what is called "Secondary solvent;" this is a benzol product, perfectly clear and has a boiling point, I think above 165° C., of which at the present time there is very little utility developed. It seems to me that this would make a fine material for stacking this sulphur.

THE CHAIRMAN: The next order of business will be to appoint a Nominating Committee to select three names to be submitted to the Institute Nominating Committee for the selection of a Vice-President to be nominated at next year's meeting. I will appoint as a Committee to bring in three names to this Section: Messrs. J. M. Morehead, A. H. White and A. B. Way. We would like to have the report at the session this afternoon, presenting three names to be given to the Institute Nominating Committee from which they will select a Vice-President for the Chemical Section to hold office after next years meeting.

The next paper is one on The Purification of Water for Gas-Making Purposes, by Mr. W. H. Fulweiler; we will leave it to Mr. Fulweiler to present it in any way he wishes.

THE PURIFICATION OF WATER FOR GAS-MAKING PURPOSES.

INTRODUCTION.

It is not the writer's intention to go very deeply into the chemistry of water purification, but rather to describe several typical plants and discuss briefly their operating costs and the relation that such costs should have in the consideration of the profitable installation of water purifying systems in gas works.

USES OF WATER.

In gas works practice, water has three general uses: to raise steam in the boilers; as a cooling agent in the condensers; and as a seal in the wash box, the hydraulic main and holders.

In the wash box, hydraulic main, and holders, the water does not come into contact with heated surfaces, therefore, there would be no reason to use specially purified water for this purpose, except should the water be highly corrosive.

In the condensers, the temperatures involved are relatively low, and there is a very rapid flow of water, so that any precipitate is generally soft and the greater bulk is carried away. Occasionally with very hard waters and when condensing facilities are limited it might be worth while considering whether it would not prove economical to roughly purify condenser water.

It is in the boiler, however, that our important problem arises. Here we have an entirely different set of conditions. The temperature of the metal surfaces is very much higher, and due to the pressure, the water attains a very high temperature. Furthermore, the water, instead of continually passing on as in the condenser, is evaporated, leaving behind in the boiler its mineral constituents, whose concentration increases at a very rapid rate. Since we are burning a relatively expensive fuel, it is necessary that the rate of heat transfer between the metal and the water should be as high as possible, both to secure economy and to insure safety. It is the purification, therefore, of boiler water that we will consider in this paper.

IMPURITIES IN BOILER WATER.

Without going into the reactions involved, we may say that the usual impurities in boiler feed water are the salts of calcium, magnesium, iron and aluminium, sodium and potassium; the acid radicals are bicarbonate, carbonate, sulphate, chloride, and occasionally nitrate; silica, clay, and organic matter generally in suspension; possibly free mineral acids, hydrogen sulphide and carbon dioxide.

In the analysis of boiler waters, we actually determine bases, such as calcium, magnesium, iron, etc., and the acid radicals, sulphate, carbonate and chloride as such, and an accurate statement of the combination of bases and radicals is extremely difficult, if not impossible. There are a number of rules for combining the radicals, but they are at best arbitrary and empirical. It would seem that the safest method of expression is that known as the ionic form, which states that there exists in the water so many parts per million of calcium, magnesium, iron, etc., and of the different acid radicals. Such a system is in accordance with the facts, while the combinations may or may not be correct. The older method, however, is more convenient and probably sufficiently accurate for the comparison of different sources.

There will be discussed later some technical methods of analysis that, while they do not determine the actual constituents of the water, do determine the effect that such constituents would have, and the necessary treatment for purification purposes.

Table I gives the analysis of a number of waters used for boiler feed purposes.

TABLE I.

Analysis of Boiler Feed Waters.

Unit—Parts per Million.

	A	B	C	D	E	F	G	H	I
Total solids	33.0	96.2	121.0	236.5	243.2	482.1	714.6	862.4	1,038.0
Iron oxide and alumina	1.1	4.4	1.7	3.0	7.5	3.4	3.4	2.4	6.0
Calcium bicarbonate	—	37.2	71.5	132.1	137.3	245.4	378.9	372.6	17.0
Calcium sulphate	5.1	10.5	14.3	—	20.4	—	—	250.0	—
Calcium chloride	7.1	—	—	—	—	—	—	—	—
Magnesium bicarbonate	—	22.1	19.9	65.0	63.2	78.3	144.2	128.3	5.9
Magnesium sulphate	—	—	—	10.3	—	45.6	—	23.5	—
Magnesium chloride	2.2	—	—	—	—	—	—	—	—
Sodium carbonate	—	—	—	—	—	—	28.2	—	697.2
Sodium sulphate	—	0.7	—	—	—	—	24.0	—	12.2
Sodium chloride	14.2	10.2	2.8	22.9	1.3	60.0	29.2	37.8	184.2
Organic and volatile	0.3	3.0	8.7	0.2	—	38.2	83.8	23.5	77.0
Silica	3.0	8.1	2.1	3.0	13.5	11.2	22.9	24.3	38.5

A = Concord, N. H., Lake water.
B = Wayne, Pa., Spring water.
C = Syracuse, N. Y., Lake water.
D = Allentown, Pa., River water.
E = Plymouth, Ind., Well water.
F = St. Augustine, Fla., Well water.
G = Des Moines, Ia., River water.
H = Sioux City, Ia., Well water.
I = Charleston, S. C., Well water.

REACTIONS IN THE BOILER.

When water containing these compounds is heated in the boiler to a high temperature and pressure and in the presence of metallic iron (which seems to accelerate some of the reactions) certain changes take place. The bicarbonates that are formed and dissolved in the water by the presence of carbonic acid are broken up, CO_2 is driven off, and the bases are precipitated, as the carbonate in the case of calcium; hydrate in the case of magnesium, and oxide in the case of iron. The magnesium chloride is decomposed and precipitated as carbonate or hydrate. Nitrates are broken up and precipitated as oxides. Organic matter is usually decomposed, forming acid compounds. Free mineral acids, if present in excess, become very active. The acid radicals of magnesium, aluminum, and iron will be set free, and under certain conditions (lack of alkaline carbonates) may attack the boiler. Apparently the chlorine ion becomes very corrosive at certain concentrations, and in the presence of metallic iron.

The above changes are generally those due directly to chemical reactions. As concentration increases, due to evaporation of the water, certain salts which are sparingly soluble reach the limit of their solubility and are precipitated, such as calcium and magnesium salts. These are the salts that are generally known as incrustants, and when precipitated under certain conditions, form a hard scale on the metallic surfaces with which they come into contact. In the case of the alkali salts, *i. e.*, the potassium and sodium, their solubility is very great, and their concentration may arise to such an extent that together with other soluble salts they begin to affect the surface tension of the water, which has now become really a concentrated, and in some cases a saturated, solution of chemical compounds.

The following table gives the solubility of a number of the constituents:

TABLE II.—SOLUBILITIES OF BOILER WATER CONSTITUENTS.

Salt	Parts per million cold	Parts per million hot
Calcium sulphate	2,330	2,170
Calcium bicarbonate	385	——
Calcium carbonate	13	——
Calcium nitrate	54,800	——
Calcium oxide	1,320	600
Magnesium bicarbonate	1,954	——
Magnesium carbonate	1,800	——
Magnesium hydrate	8	——
Magnesium sulphate	332,000	——
Magnesium chloride	540,000	——

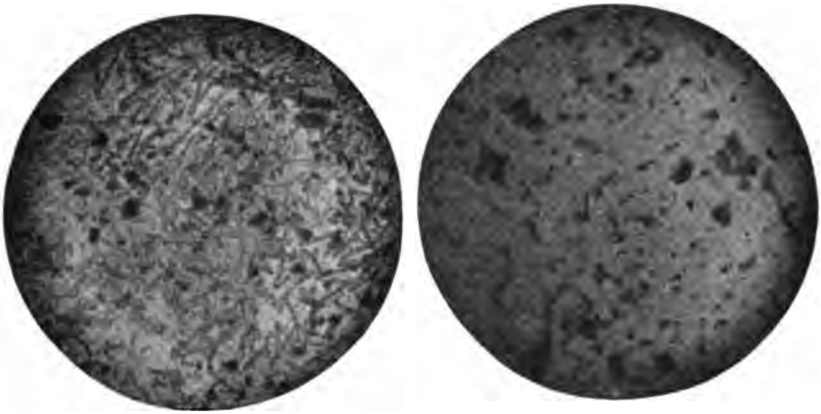
These reactions result in three distinct sets of phenomena, whose relative importance is determined by the character of the combined elements. These are, the formation of scale, the corrosion of the metal parts of the boiler, the foaming or priming.

SCALE.

The formation of scale is the most serious and the most general result of the use of what are known as hard waters. Scale consists generally of concentric layers of a crystalline deposit of calcium and magnesium salts, together with the bulk of the silica and organic suspended matter, and its presence even in very thin layers seriously lowers the rate of heat transfer through the boiler tubes and may cause "burning out" of tubes.

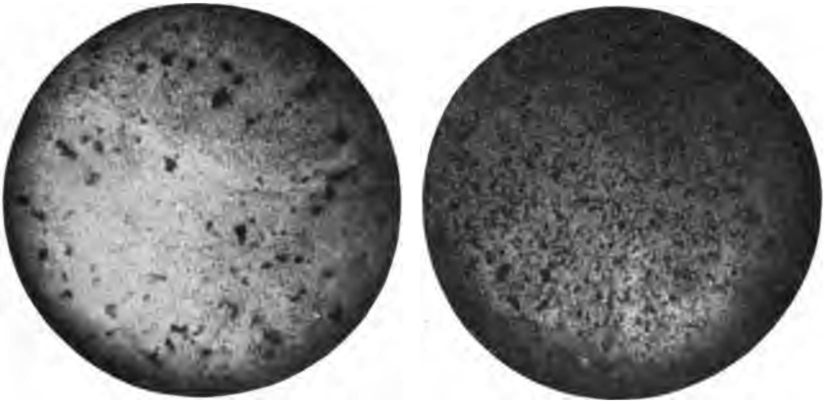
The character of the scale depends almost entirely upon the nature and method of combination of the constituents in the water. In a very soft water the excess of carbonates precipitated carries down a greater portion of the calcium sulphate, and hydrate and oxides of magnesium; the scale is generally soft and bulky and a considerable portion of the precipitated matter comes down as a sludge which may readily be blown out of the boiler. This action is accelerated where the water is muddy and contains a considerable quantity of suspended matter.

On the other hand, and especially where magnesium salts and sulphates of calcium are high, and where the water is very clear, the scale is likely to come down as a very dense compact coating over the tubes, which is exceedingly difficult to remove and greatly reduces the transmission of heat, with the attendant danger of blistering the tubes and causing bagging in the sheets.



High Magnesium Water. **High Calcium Water.**

FIG. 1.—Micro-photographs of Boiler Scale.

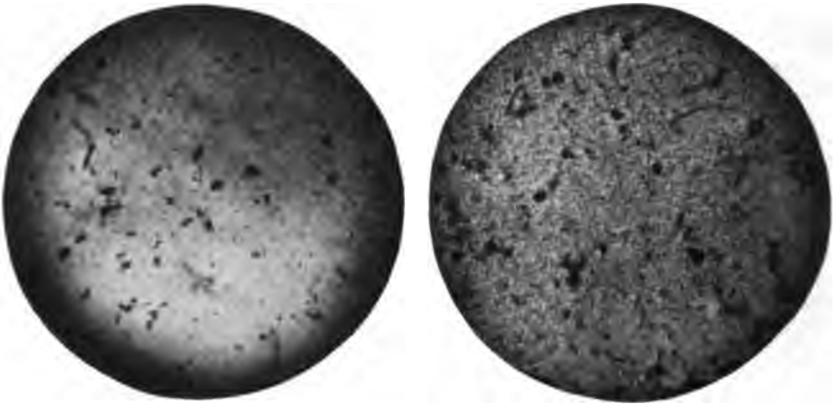


Water Treated with Soda Ash and Lime. **Water Treated with Soda Ash and Lime.**

FIG. 2.—Micro-photographs of Boiler Scale.

We have made several experiments with different types of waters, and the accompanying micro-photographs show the nature of the precipitated scale.

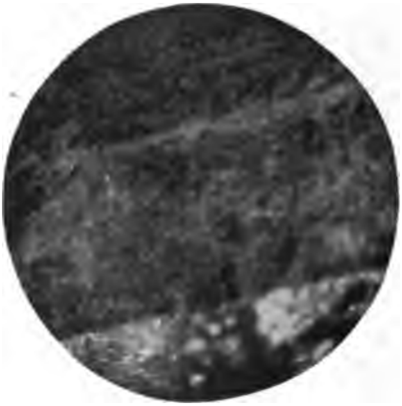
The effect of various methods of treatment on the character of the precipitated material is shown on the micro-photographs. A water high in magnesium and containing a considerable quantity of calcium salts was used in the experimental work.



High Magnesium Water Treated with Soda Ash and Tannic Acid.

High Calcium Water Treated with Soda Ash and Tannic Acid.

FIG. 3.—Micro-photographs of Boiler Scale.



Cross-section of a piece of Boiler Scale.

FIG. 4.—Micro-photograph of Boiler Scale.

Fig. 1 shows the precipitate from untreated water. The crystalline character is clearly marked as the individual crystals are quite apparent. Fig. 2 shows the effect of treating the water with lime and soda ash; the crystalline character has now practically disappeared owing to the change to the carbonate form. The particles are much smaller and more flocculent. Fig. 3 shows the precipitate when treated with soda ash and tannic acid as representative of one of the best types of boiler compounds. Here the same small size of particle and flocculent nature is noticeable. Fig. 4 is a cross-section of a piece of boiler scale, the concentrated growth and crystalline character is clearly marked.

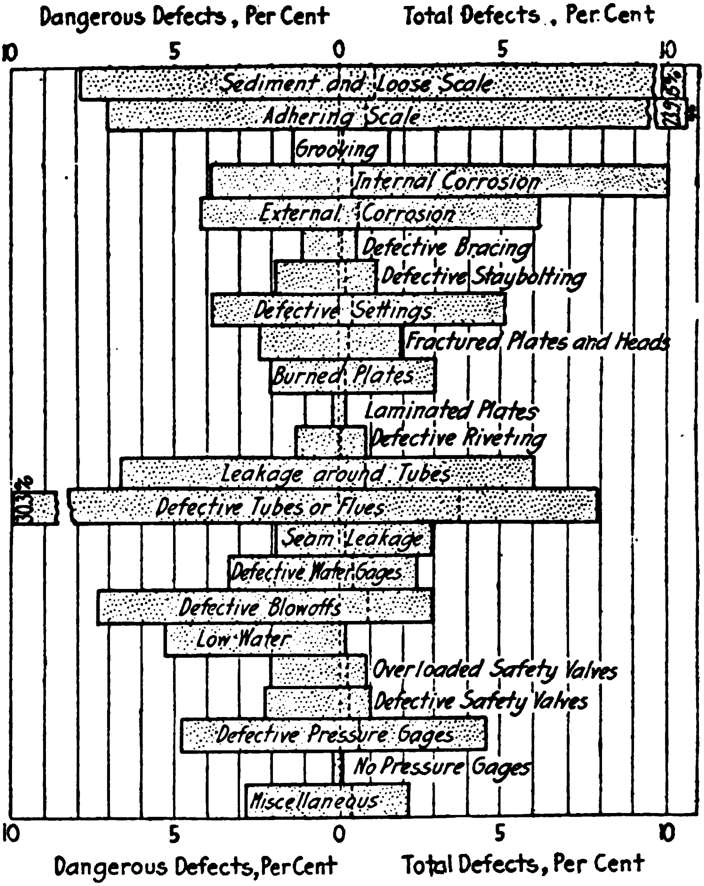
CORROSION.

The exact nature of the corrosive action of boiler water is not clear. It is probably due to several causes; presence of free acids originally present in the water, to the organic acids formed by the decomposition of organic matter at high temperatures, to the presence of free CO_2, excessive dissolved oxygen, and to the acid radicals originally combined with the iron, aluminium, and magnesium which have been precipitated as hydrates. These acid radicals will probably recombine with the carbonates, if present, but if the acid radicals are in excess, conditions may arise in which they will be free to combine with the iron in contact with the water.

Stabler, in a very excellent paper in the *Engineering News,* Vol. LX, p. 355, has evolved a formula for determining the probable corrosive character of boiler water, in which he balances the acid radicals, from iron, aluminium, and magnesia, against the bicarbonates and carbonates; and as to whether the result is plus, zero, or minus, he calls the water corrosive, possibly corrosive, and non-corrosive.

The importance of these factors is shown in the accompanying chart published by the Hartford Steam Boiler Insurance Company.

CAUSES OF BOILER DEFECTS ACCORDING TO FREQUENCY OF OCCURRENCE.



ANALYSIS OF BOILER DEFECTS ACCORDING TO CAUSES

FIG. 5.

FOAMING OR PRIMING.

The exact causes of foaming or priming are not well known. It is probably due, at least in part, to the effect of the dissolved salts (in high concentration) on the surface tension of the water, which prevent the free escape of the bubbles of steam gas. The presence of finely divided scale and excessive organic matter, in some cases, have been held to be contributing factors. Apparently the design of the boiler and the rate and manner in which the steam is taken off has a very considerable effect on this difficulty. If we assume that the fundamental cause of the trouble is the presence of alkaline salts and high concentrations, Christie, in his "Boiler Water," has given some figures showing the concentration at which foaming may be expected to begin. Expressed in parts per million, they are as follows:

Type of boiler	Foaming or concentration parts per millon
Locomotive	2,500 to 3,500
Sterling	4,000 to 5,000
B. & W. and Heine	5,000 to 7,000
Horizontal tubular return	8,000 to 10,000
Old type return boiler	17,000

The limiting factor in the treatment of water by the lime soda process is apparently the trouble due to foaming caused by the excessive amounts of reagents that must be used. This is due to the fact that all of the sodium put in as carbonate or hydroxide remains in the treated water. The practical limit seems to be water carrying about 900 parts per million of permanent hardness. Assuming that it contained in addition some 100 parts of non-incrusting solids and that the permanent hardness was made up of 200 grains calcium sulphate and 700 grains of magnesium sulphate, the water would require 163 parts of soda ash and 465 parts of sodium hydroxide, which would result in the treated water containing some 1,150 parts of dissolved solids. If this water were used in a 500 horse-power B. & W. boiler driven at its rated capacity the boiler would foam in about 14 hours.

PURIFICATION.

The problem, then, is to remove these deleterious substances or render them less harmful. This can be done either by the purification of the water before it enters the boiler, or by the addition of substances to the water as it enters the boiler. In one case, precipitation takes place outside of the boiler; and in the other, in the boiler itself.

It is apparent that if we can cheaply and economically remove these deleterious substances prior to the entrance into the boiler, this would be the most desirable and efficient method, but the necessary apparatus is a matter of some expense and ground space, and it requires supplies, repairs, attention, and supervision. On the other hand, boiler compounds are applied practically without any supervision and with a minimum of apparatus.

The relative merits, costs and results attained will be discussed later.

Methods of Purification.

The technical literature and the Patent Office records are both filled with methods for the purification of boiler feed waters. These may be divided generally into four classes:

(A) Simple heating of the water to the temperature it would attain in the boiler.

(B) Treatment of the water with various chemicals. This might be subdivided into four classes: cold continuous, cold intermittent, hot continuous, and hot intermittent treatments.

(C) The use of artificial zeolite.

(D) Miscellaneous treatments.

In the first class, that of simple heating, the theory is that when the water is brought to the same temperature as that existing in the boiler, all the precipitation will take place in the apparatus itself, in pans or other devices that can be readily removed and cleaned. The difficulty here, however, is that it entirely ignores the chemical and physical effects due to concentration; and while it is true that the bicarbonates (the temporary hardness) are precipitated upon heating, this reaction takes place slowly, and in the ordinary apparatus of this type sufficient time is not allowed for the reaction to be completed, so that while some of the bicarbonates are precipitated in the apparatus, precipitation continues, and usually results in trouble in feed lines and in the boiler itself.

Since the effect of concentration is ignored, the calcium salts are not precipitated at all, and these, together with the magnesium salts, form 90 per cent. of the scale.

It is in the second class that we have the greatest diversity of methods, apparatus and mechanical devices.

The theory of the chemical treatment of water may be expressed in the ionic form as follows:

Fe requires 2(OH)
Al requires 3(OH)
Mg requires 2(OH)
Ca requires (CO_3)
H requires (OH)
HCO_3 requires (OH)
CO_2 requires 2(OH)

and following Stabler, the lime and soda required may be calculated from the following equations:

$$CaO = 0.00931\ Fe + 0.0288\ Al + 0.0213\ Mg + 0.258\ H + 0.00426\ HCO_3 + 0.0118\ CO_2.$$

$$Na_2CO_3 = 0.0167\ Fe + 0.0515\ Al + 0.0232\ Ca + 0.0382\ Mg + 0.462\ H - 0.0155\ CO_3 - 0.001163\ HCO_3.$$

This formula is not in a very convenient form and furthermore requires a complete analysis for its application. In our own work we make our treatment depend upon the determination of the temporary and permanent hardness as described in the Appendix, and assume that the following equations represent the reactions:

Precipitated by Sodium Carbonate (Soda Ash)

A. $CaSO_4 + Na_2CO_3 = Na_2SO_4 + CaCO_3.$
$Ca(NO_3)_2 + Na_2CO_3 = 2NaNO_3 + CaCO_3.$
$CaCl_2 + Na_2CO_3 = 2NaCl + CaCO_3.$

Precipitated by Sodium or Calcium Hydroxide.

B. 1. $Ca(HCO_3)_2 + 2NaOH = Na_2CO_3 + CaCO_3 + 2H_2O.$
$Mg(HCO_3)_2 + 4NaOH = 2Na_2CO_3 + Mg(OH)_2 + 2H_2O.$

or 2. $Ca(HCO_3)_2 + Ca(OH)_2 = 2CaCO_3 + 2H_2O$.
$Mg(HCO_3)_2 + 2Ca(OH)_2 = 2CaCO_3 + Mg(OH)_2 + 2H_2O$.

Precipitated by Sodium Hydroxide and Carbonate.

C. $MgSO_4 + 2NaOH = Mg(OH)_2 + Na_2SO_4$.
$Mg(NO_3)_2 + 2NaOH = Mg(OH)_2 + 2NaNO_3$.
$MgCl_2 + 2NaOH = Mg(OH)_2 + 2NaCl$.
or $MgSO_4 + Na_2CO_3 = MgCO_3 + Na_2SO_4$.
$Mg(NO_3)_2 + Na_2CO_3 = MgCO_3 + 2NaNO_3$.
$MgCl_2 + Na_2CO_3 = MgCO_3 + 2NaCl$.

Groups A and C represent the permanent hardness, group B represents the temporary hardness.

We may have, however, three or possibly four cases to consider:

(A) in which the so-called permanent or non-carbonate hardness is just equal to the temporary or bicarbonate hardness. In this case, the addition of sodium hydroxide or its equivalent decomposes the bicarbonate to form an equivalent quantity of soda ash, which in turn decomposes the calcium sulphate. In this case, sodium hydroxide alone can be used.

(B) in which the temporary hardness is in excess of the permanent hardness. In this case, if we use sufficient sodium hydroxide to precipitate all of the temporary hardness we would have an excessive amount of soda ash formed; so that we use an amount of sodium hydroxide that reacting with the bicarbonate will form the correct amount of soda ash to precipitate the permanent hardness. The remaining hydroxide necessary for the temporary hardness is made up with lime.

(C) The third case would be that in which the permanent hardness exceeds the temporary hardness. Here a sufficient quantity of soda ash would not be formed by the reaction between the temporary hardness and the sodium hydroxide to precipitate all the salts causing permanent hardness, so that additional soda ash must be added to precipitate the remaining or excess permanent hardness.

(D) A fourth case occasionally arises where there is an excess of sodium bicarbonates.

It is somewhat simpler to consider the use of these three reagents, but practically the sodium hydroxide can be replaced by equivalent mixtures of soda ash and lime. A number of years of experience has seemed to indicate that the increased cost of the use of the sodium hydroxide is warranted, in view of the better purifying results obtained, the decreased amount of precipitate which must be removed, and the smaller amount of labor involved in the preparation and handling of the reagents.

While there is a great diversity in the details of the various chemical systems the principle is much the same in all. They consist in means for accurately proportioning according to the water used, the necessary amount of reagents, lime, soda ash, sodium hydroxide, copperas, etc., securing thorough admixture with the water to be treated, allowing the reaction a certain time to reach completion, settling out the precipitate as far as possible and then filtering the water to remove the last traces of precipitate and suspended matter.

There is some little diversity in design of the apparatus for adding the chemicals used, in the shape and size of the settling tanks, and in the method of filtering, but the principal differences are those indicated before, *i. e.*, whether the treatment is made in hot or cold water and whether it is continuous or carried out in "batches" or tanks.

In the discussion of the relative merits of hot versus cold systems, it is undoubtedly true that with heated water the reaction between the chemicals takes place more quickly, and required a somewhat smaller excess of treating chemicals to secure any desired degree of purification; and this results in a somewhat greater output (in gallons of water per hour) from a given size apparatus.

Such a system, however, generally required the use of steam to attain or control the temperature, and a certain amount of heat is lost by radiation or conduction from the water while in the system, so that there is frequently a loss of from 15° to 25° in the feed water temperature.

In discussing the continuous *versus* the intermittent system, the continuous system involves fundamentally an accurate method of proportioning the chemicals to the flow through the apparatus. This necessarily involves moving parts and attention to insure their proper operation, and the handling of milk of lime, which has a tendency to clog up everything it comes in contact with in pumps and piping systems.

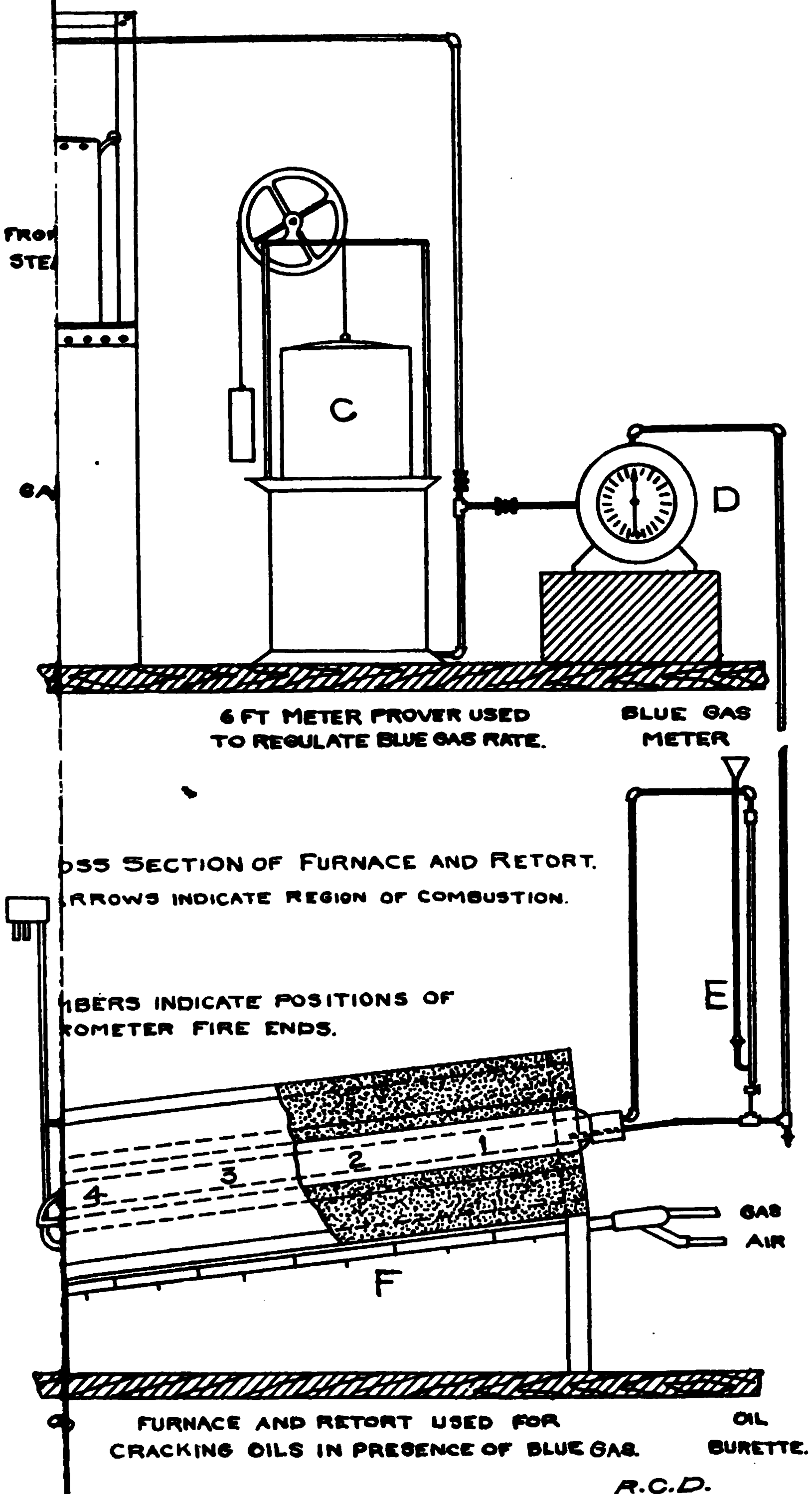
In the intermittent system, which occupies very much more space, it is very easy to secure the correct addition of chemicals for each tank of water treated, but this involves more labor in the routine of operation, but it also secures greater accuracy in the treatment.

Three systems under this general head will be described in detail.

The use of artificial zeolites is one of the more recent systems for purification. This is based upon a very interesting reversible chemical reaction. The zeolite, which is a $2SiO_2.Al_2O_3.Na_2O.6H_2O$ and has the property of exchanging its sodium ion with the calcium and magnesium ions in the water. When it has become saturated, the feed water is replaced with a 10 per cent. solution of sodium chloride. Under the influence of mass action, a reverse action now takes place, and the calcium and magnesium ions are displaced by the excess of the sodium ion present. After washing out the sodium chloride the material is again ready to begin a new cycle. The zeolites are formed as a coarse granular mass of small pieces, and are contained in relatively small iron tanks.

There is very little labor involved, and the feed water is usually passed through a tank for 10 to 12 hours, and a salt solution for about the same length of time, so that for continuous operation two zeolite treating tanks are necessary, or storage with one unit. The only expense of the treatment is the preparation and cost of the salt solution, as the zeolite material seems to last practically indefinitely.

This method of treatment will produce a water containing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6 FT METER PROVER USED TO REGULATE BLUE GAS RATE.
BLUE GAS METER
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RROWS INDICATE REGION OF COMBUSTION.
IBERS INDICATE POSITIONS OF
ROMETER FIRE ENDS.
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1
2
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4
GAS
AIR
F
FURNACE AND RETORT USED FOR CRACKING OILS IN PRESENCE OF BLUE GAS.
OIL BURETTE.
R.C.D.

absolutely no hardness, and has been very successful in waters containing a large quantity of magnesium salts, a difficult condition to handle by other systems. Its most serious disadvantage is the fact that it does not change the bicarbonate radical, and this occasionally results in an excessive amount of sodium bicarbonate, which may cause considerable trouble due to foaming. This condition can of course be overcome by a preliminary treatment with lime. However, even where considerable amounts of bicarbonates are present, the system has given very good results. It seems, however, that this method is better adapted for the preparation of very soft waters for dyeing, brewing, and other technical purposes than for boiler feed supply as its installation cost is rather high; and the difference between 0 and 60 parts per million of total hardness is not great enough in general to warrant the increased installation cost for boiler feed purposes.

There are a number of rather interesting methods of treatment coming under the fourth head, one of which consisted in allowing the water to flow over a series of aluminium plates which were freely exposed to air and sunlight. This system of operation actually gave very good results with some waters, but failed completely in the presence of any considerable quantity of iron or magnesium salts.

Another interesting system that was brought to the writer's attention was that which involved passing the water through a form of rotating mill containing a large number of small cast iron balls. Investigation showed that at least one engineer was thoroughly convinced of the complete elimination of boiler troubles, due to the use of this device.

It might be fair to state that the writer never heard of any system of feed water purification, no matter how fantastic it may have appeared but that did not have one or more advocates who were thoroughly convinced of its entire success under their conditions.

It is manifestly impossible to go into all the details of construction and operation of the various methods of treatment, so that for purposes of discussion here, three systems of chemical treatment will be described and their results analyzed, *viz.*, the cold intermittent system, the cold continuous system, and the hot continuous system. It is believed that these three will represent typical American practice.

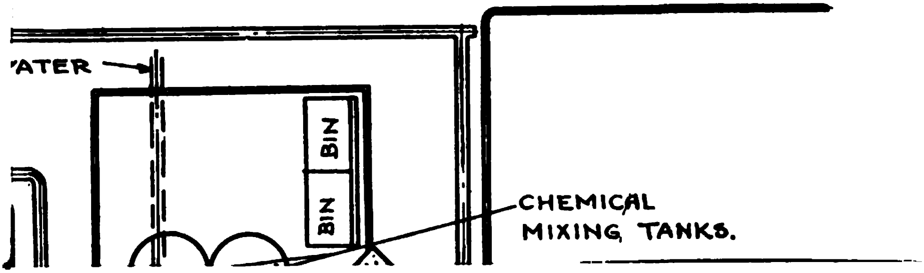
Cold Intermittent System.

The purifying system in use at the Point Breeze Works of The Philadelphia Gas Company is an example of the cold intermittent system of purification. This provides water for a plant of some 4,000 horse-power, and purifies about 400,000 gallons of water per day. The water is pumped from the Schuylkill River below the city proper, and had the following composition in September:

Constituent	Parts per million
Total solids	316.4
Volatile and organic	88.5
Silica	11.3
Iron and alumina	11.0
Calcium bicarbonate	28.0
Calcium sulphate	74.6
Magnesium sulphate	51.7
Sodium chloride	51.3

This water is subject to considerable variation, and carries at times high percentages of suspended matter. The general layout of this system is shown on plate No. 3 and photograph No. 4. It consists of five 35,000-gallon wooden treating tanks, a 20,000-gallon purified water tank, two pressure filters, and the necessary solution tanks and pumps.

The raw water is pumped into one of the treating tanks (1′, 1′, 1′′, 1′″) and calculated quantities of the necessary chemicals are mixed in the chemical tanks (2 x 2′) and blown into the treating tanks while the water is being added with steam ejectors. When the tank is filled and all the chemical is in, it is agitated with air for 30 minutes. Fig. 8-*A* shows the tank being agitated. The tank is then allowed to settle for a time determined by the demand on the system. *B, C, D* show the progress of the sedimentation. At the present time, we are treating 12 tanks per day. This allows 2 hours for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MIXING TANKS.

filling, ½ hour for agitating, 5½ hours for settling, and 2 hours for emptying.

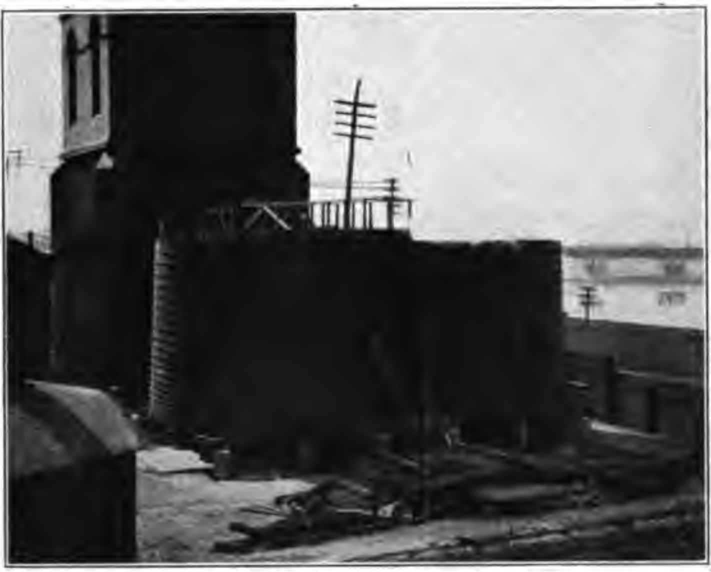


FIG. 7.—Photograph of Point Breeze Plant, Philadelphia, Pa.

The purified water is then drawn off by means of a floating suction shown on Fig. 8-*E*, care being taken not to disturb the mud that has settled at the bottom of the tank. The small amount of precipitate still remaining in the water is taken out by two sand filters, 3 x 3′. These are vertical cylindrical tanks 5 feet in diameter and 10 feet high, provided with false bottoms and filled with graded gravel and sand. The filters are washed out every day with a counter current of clear water. They require filling about every 3 years. The tanks are washed out about every 2 weeks, depending upon the season of the year.

The chemicals used in this system are sodium hydroxide, soda ash, and lime. The character of the water is such that soda ash is very rarely used. The operation is controlled by an analysis of purified water from each tank. This is necessary on account of the fact that the character of the water at times changes considerably in 10 or 12 hours. The system of control embraces a daily analysis of the raw water, analyses of the treated water from each tank, and analysis at intervals of the boiler blow-off. The methods of analysis used are described in the Appendix. Fig. 9 shows graphically the various quantities of lime and soda required during the year 1915.

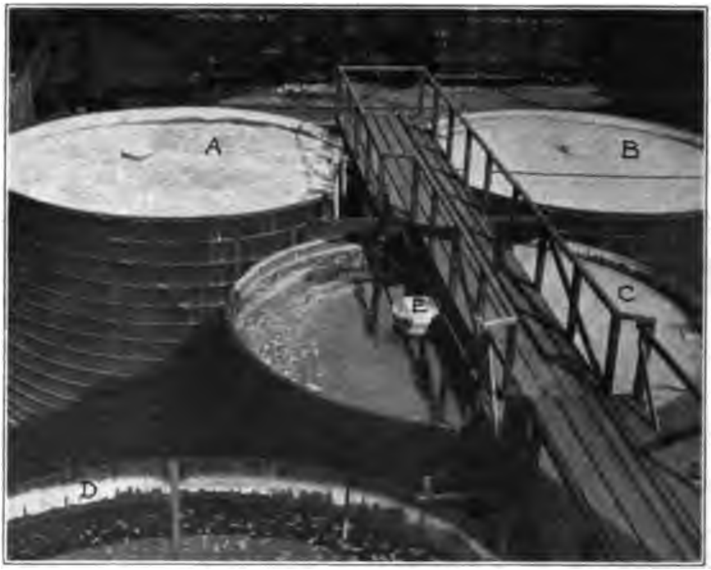


FIG. 8.—Progress of Sedimentation.

The operation of the plant is regulated so that there is an excess causticity as NaOH equal to 60 parts per million and an alkalinity due to Na_2CO_3 equal to 150 parts per million.

The operation of this plant has been very satisfactory.

The boilers are blown down to hold the concentration of the excess alkali to about 350 parts per million. The boilers are tested every 7 days, and blowing down regulated accordingly. Since the present system has been in operation they have not lost a tube. Boilers are cleaned about every 100 days, and are operating at an average load equal to 144 per cent. of their rating.

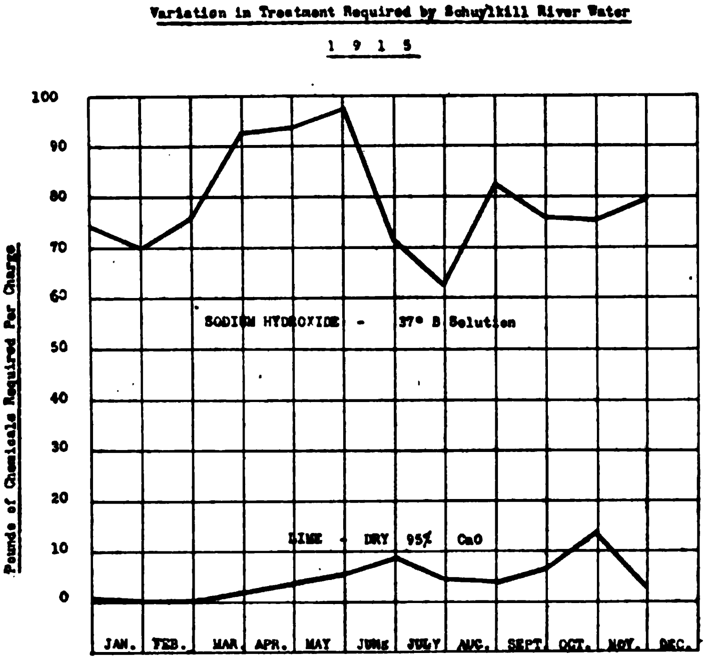


FIG. 9.

We attribute the success of this plant to the constant chemical supervision which it receives, as it is the simplest installation possible from a mechanical point of view, the only moving parts being the swing suctions and the two steam pumps.

Cold Continuous System.

As an example of the cold continuous type, the system in use by the Counties Gas & Electric Co., Norristown, Pa., will be described. This system is used to purify the make-up feed water for a station having a capacity of 2,500 boiler horsepower. The plant is rated for a capacity of 12,500 gallons per hour. During certain months in the summer, the demand is nil, while in the winter the maximum amount purified is about 6,000 gallons per hour. The raw water is pumped from the Schuylkill River about 18 miles north of Philadelphia, and had the following composition under the date given:

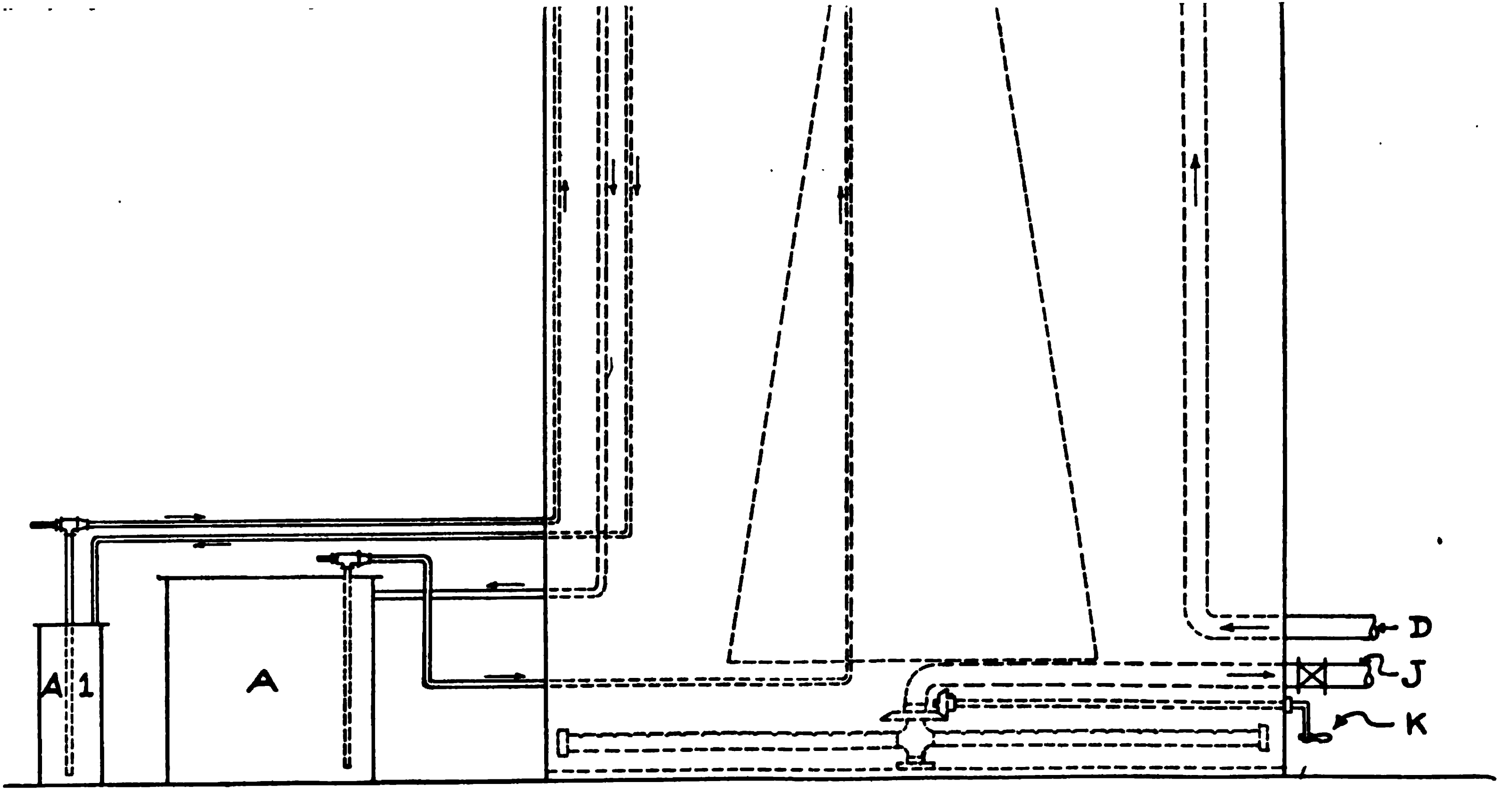
Constituents	Parts per million
Total solids	155.27
Volatile and organic	13.65
Silica	6.50
Iron and alumina	0.50
Calcium bicarbonate	15.90
Calcium sulphate	69.14
Magnesium bicarbonate	11.90
Sodium sulphate	19.05
Sodium chloride	18.63

It should be noted, however, that this water changes radically in its composition with the season of the year and the state of the river; and it frequently carries large quantities of coal dust, particularly in the spring.

The general layout of the plant given on Fig. 10 and photograph 11 is as follows:

Operation.—Calculated weighed quantities of lime and soda ash are put into the mixing tank *A* with water. The lime is slaked and the soda ash dissolved. Copperas is dissolved in tank. When thoroughly mixed and dissolved, the solutions are lifted by means of steam syphons to chemical tanks *B* and *B*-1. The agitator in the chemical tank *B* is propelled by the water wheel *C* which is in turn propelled by the incoming raw water, and this keeps the contents of the chemical tank stirred when softener is in operation.

The water to be treated enters by way of the inlet pipe *D* from a small overhead storage tank into the raw water box *E* where it is divided. The inlet water is regulated by the valve controlled by the float. The major portion of this water flows through the large opening in the raw water box where it comes in contact with the water wheel *C* and from there into the top of the downtake. A small stream flows through an opening in the raw water box into a pipe which leads to a dividing box *F* where it is divided, one part flowing into the regulating tank *G*.



COLD CONTINUOUS SYSTEM.

FIG. 10.

The function of the dividing box is to regulate the rate at which the water in the regulating tank rises compared to the rate of flow through the apparatus.

The head of the lift pipes *H* in the chemical tanks are connected by chains to a float in the regulating tank. As the regulating tank very slowly fills with water from the dividing box, the float in the regulating tank rises, the heads of the lift pipes are lowered, and the contents of the chemical tanks flow out through the lift pipe and are mixed with the raw water in the top of the downtake.

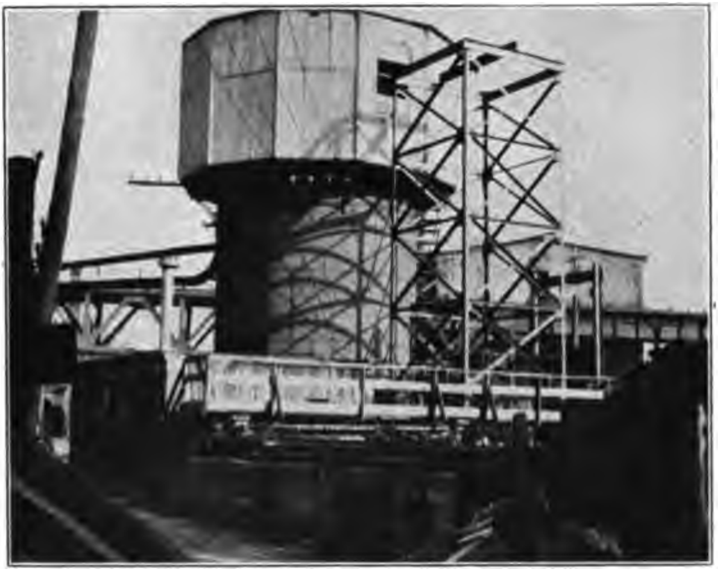


FIG. 11.—Photograph of Plant at Norristown, Pa.

The reaction between the raw water and the reagents start as soon as they meet. The mixture flows from the mixing plate at the top of the reaction cone or downtake. The precipitation of the scale-forming ingredients in the water commences to take place.

Flowing at a constantly decreasing rate owing to the constantly increasing diameter of the cone, the water passes to the bottom of the cone, turns and flows at a constantly decreasing rate upwards, the precipitate falling away from it as it moves.

Finally the water passes on to and by gravity through the filter *I* composed of about 2 feet of excelsior and burlap and which removes any trace of suspended matter and gives the soft treated water ready for use in the boilers.

The filter at Norristown is made of burlap and excelsior, but a quartz filter might be still more effective. It is necessary to replace the filter once a year. It requires 1,800 pounds of excelsior and 3 or 4 days time.

The precipitate falls to the bottom of the sediment tank and is removed once a day through the blow-off pipe *J* or sludge valve into the sewer. The sludge is stirred by the crank and agitating arms *K*, while the valve *L* is open.

TESTING WATER.

Satisfactory results are obtained by closely following the method of testing laid down by the makers. Tests of treated water are made three times every day. The tests are as follows:

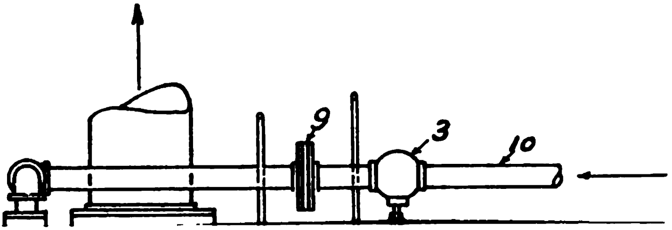
Hardness.

Measure out 100 cubic centimeters of treated water, place in bottle and add standard soap solution until permanent lather is formed. The number of cubic centimeters of soap solution added is called the hardness.

Alkalinity and Causticity.

Measure out 100 cubic centimeters of treated water, add phenolphthalein, also methyl orange, standard acid is added until red color changes to yellow. The number of cubic centimeters of acid added is called causticity. Run in more standard acid until the yellow color just changes to pink. The total number of cubic centimeters of standard acid required to produce both color changes is called the alkalinity.

The alkalinity of the treated water should be only a few



points above the hardness, and the causticity should be about two thirds of the alkalinity.

If results are not correct the makers supply a table by which the charges are changed until the results are correct.

These tests were made by the head fireman who also mixes the necessary chemicals and empties the regulating tank once a day and fills the chemical tanks. This requires about 2 hours per day.

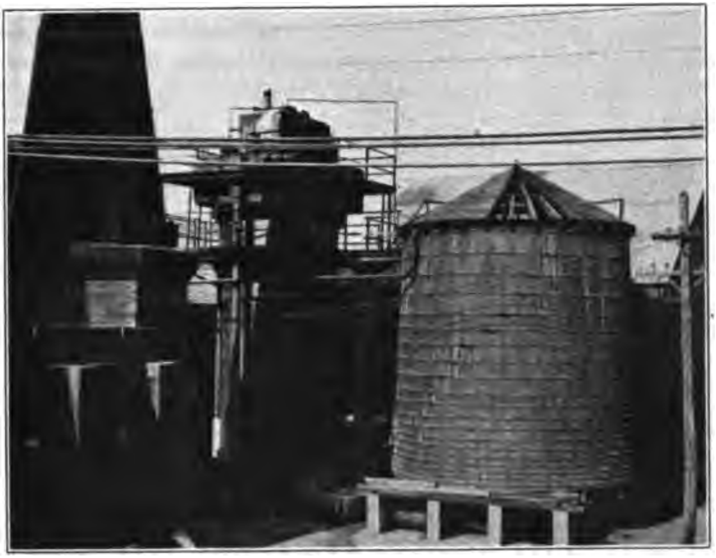


FIG. 13.—Photograph of System at Station "B" Works, Philadelphia, Pa.

It is difficult to form a correct idea of the real value of this system, as in the summer practically all the water comes from the condensers and in the winter it only operates at about 50 per cent. of its rated capacity. Under these conditions, however, the results have been excellent. The scale is very light and they have lost but two tubes during the last 3 years. There has apparently been considerable gain in fuel economy. The annual boiler cleaning is very light, and the boilers here are operated at 150 per cent. of their rated capacity. If this system were operated at its rated capacity, the reaction time would be 4 hours, whereas, at the present time, operating at the maximum rate, which is equivalent to 50 per cent. of its capacity, the reaction time is 8 hours.

The method of mixing and adding the chemicals is simple and probably sufficiently accurate; a mechanical agitator in tank, however, would suggest itself.

The location of the chemical tanks in the more or less exposed upper house requires a considerable amount of steam to prevent their freezing during the winter. The design of the settling tank seems to be a sound one; but the location of the filter makes its care somewhat difficult. It seems to require about 4 days every year to properly renew this filter and give the interior piping the necessary attention.

Hot Continuous.

As an example of the hot continuous process, that in use at the Station "B" plant of the Philadelphia Gas Works will be described. This furnished feed water for boilers having a rated capacity of boiler horse-power. The general lay-out of this plant is shown on plate 12 and photograph 13.

The raw water from the supply tank (1) enters the top of heater (2) through the regulating valve (3), which is controlled by the float valve (4) in the pump supply. The heater is of the atmospheric plate type, provided with an oil separator. The makers require that the water should leave the heater at a temperature of 200°. Live steam, if necessary, is added to the water at the outlet of the heater. The chemicals, in proportional amounts to the feed, are introduced in the stream of water as it leaves the heater. Then it passes down through a 10-inch pipe (14) into a vertical treating tank (15), 10 feet in diameter and 23 feet long, provided with a cone bottom and blow-off valve. As the precipitate is formed, it falls with the water to the bottom of the tank and is deposited and blown off at intervals. The cleared water rises through a central funnel and 10-inch pipe (16), to two filters (17-18) above the treating tank but below the heater. These filters are 10 feet 6 inches by 4 feet 3 inches, provided with an 18-inch layer of excelsior having a total filtering area of, roughly, 90 square feet. The water rises through the filter due to the heat from the heater above, which is equivalent to about 2 feet 6 inches. An overflow (19) is provided about 18 inches above the filter bed in case the filters become clogged. From the filters, purified water flows through the regulating float box to the boiler feed pumps.

The chemicals are mixed up in tank (5), which is provided with electrically driven stirrer. The centrifugal pump (6), circulates an excess amount of the liquor through the valve (7). The lift of this valve is controlled by the piston (8), which, in turn, is controlled by the differential pressure set up by the insertion of a disc (9) in the feed pipe (10) to the heater. If the flow is normal, the piston is balanced at a certain position and the valve remains practically closed, causing sufficient back pressure to force a portion of the liquid up through the by-pass (11) into the funnel (12), hence to the smaller centrifugal pump (13) by which it is fed to the apparatus. The excess liquid overflows back again to the tank (5) and is recirculated.

If the flow, however, is decreased, the lift of the valve is increased so that the bulk of the solution overflows back into the tank, a smaller quantity is forced up through the by-pass. A small motor drives the two pumps and the stirrer.

The rated capacity of this system is 12,000 gallons per hour, and at the present time it is operated at the rate of 8,000 gallons per hour. At this rate, the reaction time is about 82 minutes, and the temperature from 190° to 200° F. At full capacity, the reaction time would be reduced to 55 minutes.

The principal feature open to criticism would seem to be the short reaction time allowed at rated load and the use of two filters with such a small head. If one filter becomes slightly clogged, an excessive amount of water is forced through the other filter. This results in a small amount of precipitate passing on into the boilers. There is also some evidence of precipitation taking place in the boilers. This may probably be attributed to the short reaction time allowed.

The chemicals used at present are lime, soda ash and copperas, and the charges are based on the chemical control of the filtered water made twice a day. For sometime soda ash alone was used, but the operation could not be controlled efficiently. Recently the lime-soda ash-copperas mixture has been used, and the treatment has improved greatly. The plant is operated so that the treated water requires 1 cubic centimeter of N/20 acid for the causticity and 2 cubic centimeters of N/20 acid for the alkalinity for 100 cubic centimeters of water. This would be equivalent to 75 parts per million.

The raw water is pumped from the Delaware River above the city proper but within the manufacturing zone, September, 1916.

Constituents	Parts per million
Total solids	65.4
Organic and volatile	3.6
Silica	10.0
Iron and alumina	1.7
Calcium bicarbonate	11.3
Calcium sulphate	21.9
Magnesium carbonate	9.9
Sodium chloride	7.0

The composition of the water, however, is subject to very considerable variations, which depend upon the season, the state of the river, and the tide. This makes careful chemical control imperative.

The boilers are cleaned every 100 days, and are operated at about 122 per cent. rating. As yet, there is still considerable scale, and they lose on an average between four and five tubes per year. It cannot be said that the operation of this plant is entirely successful, but the results are improving and it is hoped that future work will render it more satisfactory.

BOILER COMPOUNDS.

It will be seen, therefore, that it is possible, with the aid of a properly designed and operated system, to eliminate such a portion of the deleterious ingredients in boiler feed water that the boilers can be safely driven considerably above their rating, and boiler repairs and cleaning reduced to a minimum, with the consequent saving in fuel and labor, and generally increased efficiency. But these systems cost a certain amount of money and require a certain installation of apparatus, so that in many of the smaller plants recourse is had to the use of so-called boiler compounds.

If we do not remove the scale-forming ingredients before they enter the water, our only recourse then is to so treat the water that when these ingredients are precipitated, they will come down in the form of loose, amorphous powders, which will not adhere to the tubes, with the resulting formation the compact, crystalline deposit, known as boiler scale. We might easily fill a page with a list of substances that have been exploited for use in the treatment of feed waters: ten levers, oatmeal, potato peelings, molasses, kerosene, graphite—nothing seems to be too fantastic. Yet all of them seem to work under certain conditions. They might be divided, however, for purposes of discussion, into three general groups, according to their apparent method of operation, *viz.*, chemical, colloidal and mechanical.

The chemical compounds comprise a large number of materials, such as soda ash, sodium silicate, sodium fluoride, disodium hydrogen phosphate, sodium bichromate and barium salts. Fundamentally, they are intended to cause the precipitation of the calcium and magnesium salts, that cause the permanent hardness as carbonates, as the carbonates come out as loose, porous precipitates; while the sulphates of calcium and the hydrate of magnesia would form dense scale. Since soda ash is the cheapest, it forms the basis, and the greater part, in fact, of most of these compounds. A typical analysis of one of these compounds is as follows:

TYPICAL ANALYSIS OF BOILER COMPOUNDS.

	Per cent.
Moisture	17.05
Sodium carbonate	70.11
Sodium hydrate	11.88
Sodium chloride	Trace
Undetermined	0.96
	100.00

Cost, six (6) cents per pound.
Cost of ingredients at current price, 1913, 2.62 cents.

In the second class are compounds usually of vegetable or organic nature, that seem to depend for their successful use on preventing the particles of precipitated material from adhering to the tubes, and causing them to go down as a fine mud. The basic ingredient seems to be tannic or a related acid, and their action seems to be that of a protective colloid, in that it causes the precipitation of the salts as amorphous powders, and not in a crystalline form. This action of tannic acid is well known in its use in the manufacture of colloidal graphite and in the manufacture of clay. Of the other organic materials that have been used for this purpose, these probably decompose at the temperature in the boiler, forming acids that have this same useful action.

Many of these compounds also contain a certain amount of soda ash to assist in precipitating the salts causing the permanent hardness, in a less harmful form, and to neutralize any free acids that would interfere with the protective action of the tannic acid.

In certain waters, compounds of this class are frequently very successful while under other conditions they seem quite useless. The presence of considerable quantities of magnesium salts, and the sulphates and chlorides of sodium, are apparently inimical to their successful use.

The third class of compounds attempt to prevent the formation of hard crystalline scale by their effect on the surface of the iron in the boiler so that the scale either does not adhere, or is broken up as soon as it attains any thickness. Graphite and kerosene belong to this class; and as usual with this system of treatment, excellent results have been reported, and again complete lack of success.

A fundamental difficulty in the use of boiler compounds would seem to the writer to be the fact that no attempt seems to be made generally to control the quantity of compound used with the variations of the boiler feed; and with the concentration of the material that must take place within the boiler itself. It will be seen from a glance at Fig. 9 that for instance the amount of sodium hydroxide solution required changes from 63 pounds to 97 pounds as the average of June and of August; and the lime changes from zero in February and March to 13.6 points in November. Furthermore, all of these compounds are relatively expensive. Lime and soda ash are two of the cheapest commercial chemicals, and it would seem, therefore, that since some supervision is essential, that by properly supervising the application of calculated quantities of these two reagents we could secure at a minimum of expense practically all of the advantages that any of the patented, and therefore, much higher priced materials could possibly possess.

For comparison, the results of using patented boiler compounds and calculable mixture of lime and soda ash at the plants are included in the following table of costs that exhibits the labor cost, the cost of supplies, repairs and depreciation, in the three types of purification systems, and in the two plants using boiler compounds.

No attempt has been made to credit the water purifying systems with any economy due to fuel saving.

From this it will be seen that taking everything into consideration from a cost standpoint, the installation of a water purifying system is not an expensive luxury. In the writer's opinion, it is fundamentally a question as to whether the plant can afford to allow a man with fair general knowledge to devote an hour a day of his time to the supervision of the treatment.

TABLE OF COMPARATIVE COSTS OF TREATING BOILER FEED WATER.

Plant	A	B	C	D	E	F
System	Boiler compound	Boiler compound	Boiler compound	Cold intermittent	Cold continuous	Hot continuous
Original total hardness of water.....	6.20	15.90	23.10	10.0	5.18	3.27
Labor operating	0.150	Nil	Nil	0.732	0.350	0.255
Chemicals	1.019	4.740	5.120	1.865 (B)	0.563	1.010
Repairs purifying plant	Nil	Nil	Nil	0.031	0.336	0.212
Interest and depreciation	Nil	Nil	Nil	1.180	2.380 (C)	1.698
Total purifying cost	1.169	4.740	5.120	3.808	3.629	3.175
Cost per grain total hardness........	0.188	0.298	0.221	0.381	0.700	0.971
(A) Cost calculated at 3.27 grains...	0.615	0.975	0.722	1.250	2.300	3.175
(B) Cost cleaning boilers...........	3.090	1.980 (A)	3.750	1.181	1.300	2.210
Reference figure (A + B)	3.705	2.955	4.472	2.431	3.600	5.385

The above figures are in cents per 1,000 gallons of feed water treated.

A. Low cost due to large units and moderate load.

B. High chemical cost due to use of caustic soda at war prices.

C. Excessive cost due to small quantity treated in a large plant.

The required chemical tests can be taught any intelligent foreman in a few hours; and the necessary calculations can be made mechanically. The testing solution can be purchased already made up so that the entire testing equipment need not cost over $15 to $20, and its use involves merely the simplest and most elementary forms of procedure.

Without constant supervision, it seems certain that any method, either of purification or the use of compounds, will inevitably fail to be successful, and on the other hand, with intelligent supervision the simple addition of properly prepared mixtures of lime and soda ash to the water—either in a tank prior to the admission of the water to the boiler, or in the boiler itself—cannot fail to result in a noticeable saving in cleaning, repairs, fuel, depreciation of the boiler, ability to carry higher loads, and greater safety and continuity in operation.

In the Appendix will be found an outline for the technical analysis of a boiler water, and two methods for calculating the treatment required for softening.

Tables for the strength of soda ash and caustic soda.

An abstract of Stabler's formulas for calculating the probable nature of boiler waters.

A short bibliography of American literature on boiler waters.

The writer takes this occasion to thank Messrs. Bruff, Desher, Bryans, Carter, Grange, Cannon and Kunberger for their assistance in compiling the detailed analyses and figures used in this paper.

APPENDIX.

TEMPORARY HARDNESS.

Measure 200 cubic centimeters of the water into a porcelain evaporating dish and add 0.5 cubic centimeter of lacmoid solution (2 grams in 1 liter of 50 per cent. alcohol). Add N/50 sulphuric acid to the water from a burette until within 1 or 2 cubic centimeters of the amounts necessary for a neutralization have been added. The dish is then placed on a tripod and the contents heated until bubbles of steam begin to break at the surface of the water. The dish is then removed and the titration continued until a drop of the acid striking the surface of the liquid and sinking to the bottom of the dish produces no change in the uniform reddish or purple color of the solution.

The number of cubic centimeters of N/50 sulphuric acid used when multiplied by 20, gives the number of parts per million of alkalinity in terms of calcium carbonate.

TOTAL HARDNESS.

Boil down the solution from the temporary hardness determination to 100 cubic centimeters, dilute up to 200 cubic centimeters, add 25 cubic centimeters N/10 soda reagent and again boil down to 100 cubic centimeters, dilute to 200 cubic centimeters with freshly boiled distilled water. Filter, rejecting the first 50 cubic centimeters and titrate 100 cubic centimeters of the filtrate for excess of soda reagent, using N/20 sulphuric acid and erythrosine as an indicator.

If S = N/20 cubic centimeters, H_2SO_4 equivalent to soda reagent used, and N = cubic centimeters N/20 H_2SO_4 required for the excess (back titration), then the total hardness in parts per million of calcium carbonate equals 12.5 (S—2N).

Water containing carbonates of sodium and potassium will require a larger amount of acid to neutralize the sample after it has been treated than is required to neutralize the volume of soda reagent originally added. The non-carbonate or permanent hardness is of course obtained by subtracting the alkalinity from the total hardness.

Unless a water is very hard, it seems best, in using the "Soda Reagent" method, to obtain the non-carbonate hardness by difference, as explained in the last paragraph, rather than directly. The percentage error due to solubility is thus reduced.

BICARBONATE, CARBONATE AND HYDRATES.

Titrate 100 cubic centimeters in the cold with N/50 H_2SO_4, using phenolphthalein as an indicator. Let this equal P.

Titrate 100 cubic centimeters in the cold with N/50 H_2SO_4, using 2.5 cubic centimeters of erythrosine (0.1 gram of sodium salt to 1 liter of distilled water and 5 cubic centimeters of chloroform) making the titrate in a stoppered glass bottle, shaking vigorously after each addition of acid. Let this equal E.

The relations are then shown by the following table from Standard Methods of Water Analysis. A. P. H. A.

	Bicarbonates	Carbonates	Hydrates
P = O	E	0	0
P / ½ E	E — 2P	2P	0
P = ½E	0	2P	0
P / ½E	0	2 (E — P)	2P — E
P = E	0	0	E

E = Erythrosine alkalinity.

P = Phenolphthalein alkalinity.

DETERMINATION OF CARBONIC ACID.

Carbonic acid may exist in water in three forms, free carbonic acid, bicarbonate, and carbonate. One-half the carbonic acid as bicarbonate is known as the "half bound carbonic acid." The carbonic acid of carbonate plus half that of bicarbonate is known as the "bound carbonic acid."

FREE CARBONIC ACID.

Reagents.—Standard N/22 solution of sodium carbonate. Dissolve 2.41 grams of dry sodium carbonate in 1 liter of distilled water which has been boiled and cooled in an atmosphere free from carbonic acid.

Preserve this solution in bottles of resistant glass, protected from the air by tubes filled with soda-lime. One cubic centimeter equals 1 milligram of CO_2.

Procedure.—Measure 100 cubic centimeters of the sample into a tall, narrow vessel, preferably a 100 cubic centimeter Nessler tube, and titrate rapidly with N/22 sodium carbonate solution, stirring gently until a faint but permanent pink color is produced by phenolphthalein.

The number of cubic centimeters of N/22 sodium carbonate solution used in titrating 100 cubic centimeters of water, multiplied by 10, gives the parts per million of free carbonic acid as CO_2.

Owing to the ease which free carbonic acid escapes from water, particularly when present in considerable quantities, it is highly desirable that a special sample should be collected for this determination, which should preferably be made on the ground. If the analysis cannot be made on the ground, approximate results from water not high in free carbonic acid may be obtained from samples collected in bottles which are completely filled so as to leave no air space under the stopper.

BICARBONATE (HCO_3), CARBONIC ACID AS BICARBONATE (CO_2), AND HALF BOUND CARBONIC ACID.

When a water is acid to phenolphthalein these three forms are computed as follows, from the alkalinity expressed in terms of calcium carbonate.

Bicarbonate (HCO_3) 1.22 times the alkalinity.

Carbonic acid (CO_2) as bicarbonate 0.88 times the alkalinity.

Half bound carbonic acid 0.44 times the alkalinity.

When the water is alkaline to phenolphthalein, bicarbonates are present only when this alkalinity is less than one-half that by methyl red or erythrosine. Then the bicarbonate alkalinity is equal to the total alkalinity by methyl red or erythrosine minus twice the alkalinity by phenolphthalein. When the difference is expressed in terms of calcium carbonate, the bicarbonate, carbonic acid as bicarbonate, and half bound carbonic acid are determined from it by the factors given above.

SCHEME FOR RAPID ANALYSIS OF BOILER WATERS.

The desired amount of water is evaporated to dryness in a platinum dish and weighed. This residue (1) represents Total Solids. Ignite, then moisten slightly with distilled water, place in an atmosphere of carbon doxide for half an hour, dry, and weigh. This residue (2) is the Total Mineral Matter combined with carbon dioxide, as it previously existed, before ignition. The difference in weight between residue (1) and residue (2) is the Organic Matter.

Extract soluble matter from residue (2) with successive small portions of distilled water, in all 50 cc. or less. Filter through ashless filter and dry the residue adhering to the platinum dish. Dry and ignite filter and return the matter it may have retained, to the platinum dish in bell jar in atmosphere of CO_2 for half hour and weigh. The weight of this residue (3) represents the total scale forming ingredients of the water.

The filtrate contains the alkalies and magnesia combined with sulphuric acid and chlorine. These may be determined if desired, but are not necessary in this operation. Their aggregate weight may be determined by subtracting residue (3) from residue (2).

Treat residue (3) with hot hydrochloric acid and filter. Wash well.

<table>
<tr><td rowspan="5">Residue. Insoluble mineral matter. Dry, ignite, and weigh as such. SiO_2, etc.</td><td colspan="4">Filtrate. Add ammonium hydroxide in slight excess, boil and filter.</td></tr>
<tr><td rowspan="4">Residue. Al_2O_3, Fe_2O_3. Dry, ignite, and weigh as such</td><td colspan="3">Filtrate. Add solution of ammonium oxalate in slight excess and set aside one half hour. Wash with water containing one-eighth its volume of ammonium hydroxide.</td></tr>
<tr><td rowspan="3">Residue. Dry, ignite, and weigh as CaO.</td><td colspan="2">Filtrate. Add solution of sodium phosphate with constant stirring. Set aside one half hour and filter. Wash with water containing one-eighth its volume of ammonium hydroxide.</td></tr>
<tr><td rowspan="2">Residue. Dry, ignite, and weigh as $Mg_2P_2O_7$ and calculate to MgO.</td><td>Filtrate. Acidify with HCl, add solution of $BaCl_2$ in slight excess, boil, set aside one half hour, filter, and wash well with hot water.</td></tr>
<tr><td>Residue. $BaSO_4$. Dry, ignite, and weigh as $BaSO_4$, and calculate to SO_3. This amount of SO_3 is combined with CaO to form $CaSO_4$ that exists in residue (3).</td></tr>
<tr><td>SiO_2, etc.</td><td>$Al_2O_3.Fe_2O_3$.</td><td>CaO</td><td>MgO</td><td>SO_3</td></tr>
</table>

CARBONATE (CO_3), CARBONIC ACID AS CARBONATE (CO_2), AND BOUND CARBONIC ACID.

Carbonate is computed as 1.2 times the alkalinity expressed in terms of calcium carbonate, as determined by phenolphthalein.

Carbonic acid as carbonate is computed as 0.88 times the same. Bound carbonic acid is computed as 0.44 times the alkalinity expressed in terms of calcium carbonate as determined by methyl red, lacmoid or erythrosine. It should be noted that half bound carbonic acid is equal to one-half the bicarbonate carbonic acid and that the bound is the sum of the carbonic acid as carbonate and one-half that as bicarbonate.

DETERMINATION OF CHLORINE.

One hundred to two hundred cubic centimeters, according to the chlorine content, are titrated with N/10 silver nitrate, using a few drops of a saturated solution of potassium chromate as an indicator. The silver nitrate solution is added from a burette until the last drop produces a faint blood-red tinge, in evidence that all the chlorine has combined with the silver. The silver nitrate solution is standardized against C. P. sodium chloride and the factor calculated to Cl.

In water analysis we combine the elements as follows:

Cl to Na, then K, then Mg, then Ca. SO_3 to Na (if not enough Cl to saturate it) then Ca, then. Mg. CO_2 to Ca and Mg; if in excess, then to Na.

LIME VALUE AND SODA VALUE.

The following methods may be employed for the determination of the amount of lime and soda required for the softening of a water.

LIME VALUE.

Two hundred cubic centimeters of the cold water to be softened are mixed with 50 cubic centimeters of saturated lime water of known strength in a 250 cubic centimeter volumetric flask and heated to boiling. The strength of the lime water must be determined for each series of determinations.

After cooling, the flask is filled to the mark with water, the contents are mixed, and 200 cubic centimeters are filtered through a dry filter and titrated in a porcelain dish with N/10 — HCl with methyl orange as an indicator. For this purpose if "B" cubic centimeters of HCl are necessary.

The milligrams of lime per liter required to soften the water tested may be computed by the following formula:

$$(4a - 5b)\ 3.51\ \mathrm{CaO}.$$

SODA VALUE.

Then add to the neutralized solution in the porcelain dish 20 cubic centimeters N/10 — Na_2CO_3 and heat to the beginning of a boiling. The contents of the dish are washed with water free from CO_2 into a 250 cubic centimeter flask, cooled, made up to the mark, mixed and filtered. 200 cubic centimeters of the filtrate are measured off and the excess of alkali titrated with N/10 — HCl. The number of cubic centimeters used is designated by c.

Then the number of milligrams of soda per liter required to soften the water treated may be computed by the following formula:

$$(20b - 5 - 4c)\ 33.13\ \mathrm{Na_2CO_3}.$$

SHORTER CONTROL METHOD FOR CALCULATING SOFTENING REAGENTS.

Place 100 cubic centimeters of the raw water in a 150 cubic centimeter Erlenmeyer flask and add 10 cubic centimeters of N/10 Na_2CO_3 solution. Place flask on a water bath and bring bath slowly up to boiling; hold for 5 minutes. Filter through a dry filter and titrate with N/10 acid using phenolphthalein and methyl orange, as an indicator. On the neutralization with phenolphthalein, note the cubic centimeters of acid and let this equal A. Then add methyl orange and continue titration. Let the total acid used equal B.

Temporary hardness $= B - 2A = T$.

Permanent hardness $= 10 - B = P$.

If $T = P$, use caustic soda only. $T \times 0.333 =$ pounds of

100 per cent. NaOH per 1,000 gallons of water; T × 1.0656 = pounds of 37° B solution.

If T is greater than P, we use P × 0.333 = pound of 100 per cent. NaOH per 1,000. P × 1.0656 = pounds of 37° B solution, and (T — P) × 0.231 = pound of dry CaO 100 per cent.; (T — P) × 175 = pounds of clear saturated lime-water.

If T is less than P, we use T × 0.333 = pound of 100 per cent. NaOH. T × 1.0656 = pounds of 37° B solution. (P — T) × 0.4412 = pound of 100 per cent. $NaCO_3$, (P — T) × 2.1130 = pounds of 26° B solution.

TABLE OF STRENGTH OF SODIUM HYDROXIDE AND CARBONATE SOLUTION.

Specific gravity	Degree Baumé	Per cent. NaOH	Per cent. Na_2CO_3
1.060	8	5.20	5.65
1.075	10	6.58	7.08
1.090	12	7.90	8.52
1.108	14	9.53	10.11
1.125	18	11.06	11.67
1.142	18	12.72	13.29
1.162	20	14.44	——
1.180	22	16.00	——
1.200	24	17.81	——
1.220	26	19.65	——
1.241	28	21.55	——
1.263	30	23.50	——
1.285	32	25.50	——
1.308	34	27.65	——
1.333	36	30.09	——
1.358	38	32.59	——
1.384	40	35.10	——
1.410	42	37.65	——
1.439	44	40.58	——
1.469	46	43.70	——
1.499	48	46.84	——
1.530	50	50.10	——

ABSTRACTS OF STABLER'S FORMULAS.

These formulas are applied to analysis reported in the ionic form.

Soap Cost in Cents per 1,000 Gallons.

$(1) = 9 + 1.79Fe + 5.54Al : 2.5Ca + 4.11Mg + 49.6H.$

Lime required for softening in pounds of (90 per cent. CaO) lime per 1,000 gallons.

$(2) = 0.00931Fe + 0.0288Al + 0.0213Mg : 0.258H + 0.00426\ HCO_3 + 0.0118CO_3.$

Soda ash required for softening in pounds of (95 per cent. Na_2CO_3) soda ash per 1,000 gallons.

$(3) = 0.0167Fe + 0.0515Al + 0.0232Ca + 0.0382Mg + 0.462H - 0.0155CO_3 - 0.00763HCO_3.$

Foaming Coefficient.

$(4) = 2.7Na + 2K.$

Non-foaming, F less than 60; semi-foaming, F60 — 200; foaming, F = more than 200. Run in hours before foaming commences.

$$(5) = RF = \frac{A}{B} \cdot \left(\frac{C}{F} - 1\right)$$

Where A = water capacity of boiler.
B = hourly quantity of feed water used.
C = constant for type of boiler.
F = foaming coefficient.
C =

Locomotive boilers	2,500- 3,500
Sterling boiler	4,000- 5,000
B. & W. and Heine	5,000- 7,000
Horizontal return tubular	6,000-10,000
Old style, 2-flue	17,000

Corrosion Coefficient.

$(6)\ C = H + 0.1116Al + 0.0361Fe + 0.0828Mg - 0.0336 CO_3 - 0.0165HCO_3.$

If C is positive the water will be corrosive; if $C + 0.0503Ca$ be negative it will not be corrosive; if C is negative, but $C + 0.0503Ca$ is positive, it may or may not be corrosive.

Quantity of Scale in Pounds per 1,000 Gallons of Water.

(7) $= 0.00833$ suspended matter $+ 0.00833Li + 0.6107Fe + 0.0157Al + 0.0338Mg + 0.0246C + Ca$ should not exceed $0.668CO_3 + 0.328HCO_3 + 0.417504$.

Quantity of Hard Scale in Pounds per 1,000 Gallons of Water.

$$(8) = 0.00833SiO_2 + 0.0138Mg + (0.016Cl + 0.0118504 - 0.0246Na - 0.0145K).$$

The value for the quantity in the parenthesis should not exceed 0.0118504 or 0.0283Ca or be less than zero.

$$\text{Coefficient of scale hardness } H = \frac{\text{Hard scale}}{\text{Scale}} = \frac{(8)}{(7)}.$$

Soft scale = H less than 0.25; medium scale = H 0.25 — 0.50; hard scale = H more than 0.50.

In addition, if S is less than 1 = very little; S is 1 — 2 = little; S is 2 — 4 = much; S is more than 4 = very much.

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(Mr. Fulweiler, at the close of a synopsis of his paper, gave a very interesting lecture on the subject, accompanied with quite a number of slides.)

THE CHAIRMAN: I think we are all greatly indebted to Mr. Fulweiler for the very interesting paper he has just read. Will some one open the discussion?

MR. A. B. WAY: Mr. Chairman, I note Mr. Fulweiler's remark that he did not like the price of that compound. Just perhaps for his amusement I will mention a compound, of which we bought a small amount, costing 24 cents. I was able to make this compound for about 24 cents a barrel. There is one phase of this subject which has been brought to our particular attention which Mr. Fulweiler passed over, and I think it merits serious consideration. What effect has the blowing down of the boiler to get rid of the excess alkaline materials, on the cost of the treatment, in terms of heat loss?

I know of a specific case, which is quite parallel to one spoken of by Mr. Fulweiler,—a case where there were 16 250-horse-power B. & W. boilers, and the alkalinity of the water about the same as that which he mentions. These boilers would have a total holding capacity of about a half million pounds of water, which would contain at all times 175 pounds of alkalies in solution, calculated on a 350 parts per million basis. Now, if 400,000 gallons or about 3,000,000 pounds of water containing 210 parts per million of alkalies were run into these boilers daily it means a daily addition of 630 pounds of alkalies, and to keep the concentration down to 175 pounds would require the elimination of about a million and a third pounds of water per day. To heat this amount of water to the temperature in the drums, at, say, 125 pounds boiler pressure would require something like 20 tons of fuel per day; basing our calculations on 14,000 B. t. u. per pound of fuel and 70 per cent. efficiency.

We had occasion to decide between the use of a water which we pump from wells five miles from the works and which would require treatment, and the use of metropolitan water, which requires no treatment, almost no compound; and when we came to consider the erection of a treating plant and the amount of blowing down that was said to be necessary, we found that if we bought metropolitan water at 8 cents per hundred cubic feet on the one hand and pumped the water from our wells at 2 cents per hundred cubic feet, on the other hand we would save money by buying metropolitan water, simply because of the extra cost of fuel necessary to heat the large amount of water we would have to draw away.

Mr. J. M. Spitzglass (Chicago): Mr. Chairman, in my opinion this paper represents an excellent treatise on water purification for any purpose, whether for gas making or steam generation.

In reading the paper I formed a notion that while Mr. Fulweiler brought out that it is best to purify the water before it enters the boilers, in a way he very nearly carried on the same basis the treatment of putting in some chemical in the boiler with the purification of the water before it enters the boiler, but when I heard Mr. Fulweiler presenting the paper, that notion was modified a little. I believe that the adding of compounds or anything else to the boiler, should never be compared with the purification of water before it enters the boiler.

Mr. Way in discussing the paper, brought out very nicely how much water we have to remove from the boilers if we do put in some compounds which, of course, does not enter into the calculations of the comparative table given on page 564 of this paper; but I would say, from my own experience, which I will give you later, that that water is not wasted, because that whole thing is not removed from the boilers. It goes into the pipes. And the reason I know about it is this: In my work with steam flow meters I usually get complaints once in a while that the meter does not work.

This happens when the openings of the Pitot tube are plugged up with scale, and we have to pull out the tubing and clean it. In some places they have to pull out a tube every day and clean out the sludge that comes with the steam. Sometimes the meter reads too high, because about half the area of the pipe is filled with scale. You will find where they use a boiler compound, if you cut a pipe, even far away from the boiler, you will find exactly the same coating that Mr. Fulweiler showed us, from the scale in the boiler. I have seen it myself in many cases. In one case, not far from here, they have been using boiler compounds. I do not know whether they bought them or used their own. After they experimented with the meter tubes in the pipes they decided they would have to put in a purifying system and clean the water before it goes into the boilers.

In the table that Mr. Fulweiler gives us, he compares the six systems on the same basis—the grain of hardness.

Now, that is not fair, because you have the grains of hardness measured at the time when the water enters the purifier or the boiler. The question is to compare it when that hardness is removed, and then you can compare it on the same basis. Now, since the boiler compound did not remove anything from the boiler, therefore the cost per grain of hardness will be almost infinity. (Laughter.)

I will say that again. In presenting the paper, Mr. Fulweiler told us several times that the main thing is to purify the water before it enters the boiler; but he suggested that we need a man to watch it. Of course, that is true for best results. But I believe even if you have no one to observe it closely, it is still better to purify the water somehow than to let it go through the boiler as it is; or else buy city water, as Mr. Way has suggested.

There is one question I would like to ask Mr. Fulweiler. In Table II on page 580 where he gives the solubilities of boiler water constituents.

Does that solubility apply the same, whether you have only one of those constituents, or many of them together? Will it still dissolve the same amount as given in this table?

And another question is: It is given here that it dissolves so many parts—per million for instance, the first one dissolves 2,330 parts of Calcium sulphate per million cold, and 2,170 parts per million hot. Do we understand from this that if the water is hot it dissolves less of the salt than when it is cold?

Not knowing much about chemistry, I thought when we heat water it is more soluble for any salt. If I am wrong, of course then I will admit it.

A MEMBER: You are wrong.

MR. SPITZGLASS: I had that notion, that the result with hot water was quicker.

One more word about the comparative table. I want to bring out the fact that in whatever way we can do the work we should rather purify the water before it enters the boilers than put it in the boilers as it is, because there will be added the cost of cleaning the boilers and the cost of cleaning the pipes a long distance from the boilers.

MR. M. G. WELSH (Schenectady, N. Y.): I would like to ask Mr. Fulweiler, in figuring the cost of cleaning boilers, did you figure just the cost of cleaning the tubes, or opening the boiler? It is quite a different proposition to open a B. & W. boiler, than it is a Stirling boiler. If he figures the time of opening a B. & W. boiler as well as cleaning, I do not think it is fair for the comparison, because it takes a great deal more time to get a B. & W. boiler ready to clean than it does a Stirling, while the same length of time might be required to clean the tubes which would be properly chargeable against the boiler compound.

MR. M. E. MUELLER (New York): Mr. Fulweiler has explained the function of the lime and caustic soda in the purification of water, and he also mentioned the use of copperas, but did not explain the use of this constituent.

MR. F. W. SPERR, JR. (Pittsburgh, Pa.): I have a point to bring up which is suggested by the title of the paper, although it does not so much concern the specific subject of boiler water purification. The paper is an admirable treatise on this subject and we are to be congratulated in having Mr. Fulweiler present it to us in this way.

What I have particularly in mind is the possibility of purifying or neutralizing the corrosive qualities of certain condenser waters. Recently several cases have come to my attention where saline or acid waters are used and the steel tubes of the condensers and other cooling apparatus have to be replaced in the course of 18 months or so. This, of course, is an expensive proposition. We have to choose between it and making the tubes of heavier material (say cast iron) so that they will last longer; or else find some means of neutralizing the action of the water. It is out of the question actually to neutralize the acid in such large quantities of water; but we might employ a device that has been successfully used in the case of many corrosive boiler waters. This is to suspend zinc plates in the water and connect them with the steel tubes, etc., so as to form a galvanic couple protecting the iron at the expense of the zinc. I should be much interested to hear if anyone has tried this. I personally should not recommend it as a substitute for water purification for boiler practice, although it has been stated to give good results; but it certainly offers possibilities for the inexpensive protection of condensers and other apparatus exposed to the action of large quantities of corrosive water.

THE CHAIRMAN: I will call upon Mr. Fulweiler to close the discussion.

MR. FULWEILER: I am glad that attention has been called to the question of the advisability of the treatment of water before entering the boiler or in the boiler. I do not think we should ever use a boiler as a means of carrying on chemical reactions unless we are absolutely forced to it, and I do not feel that there is really any good argument against treatment of water before it enters the boiler except that of space. I believe that even very small plants would find it possible to rig up a simple treating system, composed of several tanks and a wooden filter operated by gravity. A pump, a steam injector and a pair of scales would complete the equipment. If as mentioned in the paper, you have some one who can watch the addition of the chemicals, you are sure to get results and the cost of installation and operation would be so low that it is certainly worth consideration even in the smaller plants, unless the room for the tanks is not available.

The compounds are easy to use, under many conditions give fairly satisfactory results and they are generally sold by clever salesmen.

With reference to solubility, generally the solubility of a salt in water increases with the temperature, but there are some salts that are less soluble at high temperatures than at low temperatures. In other salts, the solubility may vary with the temperature, such as Glauber's salts. Here you may have practically a solid, as the temperature rises it becomes liquid, at still higher temperature it becomes solid again. The solubility of many salts is effected by the presence of other constituents in the solution. Some salts are rendered much more soluble, while others are practically precipitated by the presence of another component.

Treatment with Copperas: It seems that in some systems where they have only a small amount of material to be removed, it is difficult to filter that small amount, and where the suspended material runs up a little they find it advantageous to add copperas and then an excess of lime to act as a coagulent. This increases the efficiency of the filtration.

Regarding the cost of cleaning: The figures I used included the opening of the boiler, the actual cleaning of the tubes themselves and replacing. They did not include firebox repairs. In that connection it is only fair to state that it costs a lot of money to open up a B. & W. boiler, but that is very easy to clean when you get it open, and I think in the long run these factors average up pretty well.

About zinc plates: There is probably more literature on the use of zinc plates as preventatives of corrosion than almost any feature of boiler treatment; and it is my understanding from the later discussions that the use of zinc plates is not as well thought of as heretofore; in other words, the evidence now is tending against them.

THE CHAIRMAN: I think I voice the sentiments of the Session and Institute in thanking Mr. Fulweiler for his very interesting paper.

Before we close we have an announcement to make. The American Gas Industry Manufacturers' Association has a very complete exhibit of instruments used in the manufacture of gas, in the Florentine Room; you are invited to attend.

We meet this afternoon in the Gold Room. There will be a few Distribution matters to be disposed of and I hope you will be there promptly.

(A motion was made and duly seconded to adjourn. The motion prevailed.)

Adjourned.

CHEMICAL SECTION.

Second Session, Thursday, October 19, 3.45 P. M.

MR. R. B. HARPER, *Vice-President*, presiding.

MR. LOUIS J. BECKER, *Secretary*.

THE CHAIRMAN: First is a report of the Committee on Chemical Tests which Mr. Fulweiler will read.

MR. W. H. FULWEILER: Mr. Chairman, owing to the unavoidable absence of Mr. Tutwiler, the Chairman of the Committee on Chemical Tests, which completed the Gas Chemists Handbook, and which I think is the important thing that Mr. Tutwiler wished to bring out. I am going to burden you with reading this report.

REPORT OF COMMITTEE ON CHEMICAL TESTS.

Since the last meeting of the Institute, the Committee on Chemical Tests has directed its activities chiefly toward the revision of the Gas Chemists' Handbook, compiled in 1914 by Mr. W. H. Fulweiler.

Mr. Fulweiler, in presenting his report at the Ninth Annual Meeting of the Institute, stated as follows:

> The magnitude and delicacy of this work is fully realized and this is presented primarily as a progress report. In time, the Institute would be well repaid for the expense incurred in the publication of such a handbook by the uniformity of practice that would result from the adoption of these methods and by the convenience to the gas chemist of having recognized standard methods pertaining to the industry collected in one convenient publication.

While the first issue of the Handbook was a very decided step in the right direction, it was recognized that much was still to be accomplished and the continuance of the work devolved upon the 1915 Committee on Chemical Tests. This Committee was unable to do more than report satisfactory progress at the 1915 meeting of the Institute and the same Committee was re-appointed to continue the revision over 1916.

It was felt from the start that it was of first importance that the work should be carried out by a committee whose activities covered as wide a field as possible, not only in the gas industry but in collaterial lines as well, especially in the coke oven and coal tar by-product industries which are becoming yearly more closely identified with the gas business. For this reason, special effort was made to enlist the co-operation of chemists skilled in these various lines and I have felt myself and the Institute most fortunate in having secured the assistance of the gentleman who served with me on the Committee in 1915 and 1916.

Mr. Fulweiler, in concluding his report, states:

> It is urged that special attention be given to the question of standard methods and to the peculiar conditions under which samples must be taken in the gas industry.

The Committee has felt with Mr. Fulweiler that the standardization of methods of testing and sampling was the chief consideration to which it should devote its attention, and in the Handbook which we now offer for your consideration, we have endeavored to round out as far as possible the work of the first committee and to standardize and bring up-to-date methods which have been developed or improved since the work was inaugurated in 1914. It is hoped that owing to the wide connections of the members of the Committee and the various sources from which these methods have been drawn that progress has been made toward the accomplishment of this much desired result.

The Committee has devoted a considerable amount of time to the consideration of proper methods of sampling, recognizing the fact that unless the sample is properly taken, the analysis might not only be worthless, but absolutely misleading. We have endeavored to have the directions for sampling as well as for testing so clear that little difficulty will be encountered even by chemists of limited experience.

The Committee, recognizing the great progress being made in the application of chemistry to the gas industry and feeling that even companies of moderate size can well afford to have on their staff chemists or men of some chemical training, has kept in mind primarily the assistance of these men rather than the engineer, although it has endeavored to present the subject matter in a manner which may be easily understood by all. It will be noted that no attempts have been made to interpret the results of the analyses, nor have theoretical considerations been touched upon to any great extent, it being felt that this phase of the subject might better be left to succeeding committees, possibly to be covered in a separate publication.

We have included in the Handbook such of the most useful tables of constants and data as are most frequently required. But in view of the fact that there are now so many reference books readily available, matter of this kind has been kept to a minimum.

While the Committee feels that distinct progress has been made in the Handbook, it is not prepared to recommend that all of the methods contained therein be stamped with the official approval of the Institute without further revision by succeeding chemical test committees or by a special committee appointed for the purpose, except possibly the methods covering the analyses of coal and coke, cement, and iron and steel. All of these may safely be adopted, it is thought, since the method for analyses of coal and coke is based on the work of the Bureau of Mines and those for cement, iron and steel are the official methods of the American Society for Testing Materials. The desirability, however, of having the whole work officially approved by the Institute seems apparent and since its value would be so much increased by such action of the Institute, the Committee feels that no unnecessary time should be lost in taking the necessary steps to further standardize and enlarge the work.

In conclusion, I wish to express to the various members of the Committee, my appreciation of their efforts in behalf of the success of the Handbook and especially of the efforts of those gentlemen not directly engaged in the gas business, who have given their assistance. It seems proper in this connection to make special mention of the work of Mr. S. R. Church, Manager, Research Department, The Barrett Company.

I also wish to express my appreciation of the efforts of Mr. A. F. Kunberger, who was appointed editor of the Handbook since the last meeting of the Institute and upon whose shoulders has devolved most of the work in connection with getting into suitable form for publication the data secured by the Committee.

C. C. TUTWILER, *Chairman,*
A. P. BEARDSLEY,
S. R. CHURCH,
W. H. FULWEILER,
R. G. GRISWOLD,
J. M. MOREHEAD,
E. C. UHLIG,
C. R. RAMSBURG,
A. B. WAY,
A. H. WHITE.

THE CHAIRMAN: Gentlemen, what is your pleasure concerning this report?

MR. HERMAN RUSSELL: I would like to ask Mr. Fulweiler if it is the intention now to have this book published?

MR. FULWEILER: It is my understanding of the situation that the book—you can see the page proof here. Of course this is only printed on one side of the sheet—contains about 365 pages. It is my understanding that the matter of the exact method of publication has been left to the Institute's Publication Committee, the idea being that this book should be brought out as such and sold by the Institute, providing further action is taken as the methods are not officially approved as yet. It is hoped that such official approval may be obtained. But the committee was, as expressed in the report, not ready to ask for an official approval on all of the methods. They felt that some of them still require more work being done before the Committee was ready to ask for official approval.

I might add that a great many of the methods are standard methods and have been adopted by other societies whose principal aim it is to do that sort of work, in particular the American Society of Testing Materials. It is their particular province to standardize chemical methods.

MR. RUSSELL: Mr. Chairman, I would like then to make the motion, that the Chemical Section recommend the publication of this book by the Publication Committee, and the distribution of it under such terms of payment as they may see fit to work out.

THE CHAIRMAN: It has been moved and seconded. All in favor please signify by saying aye. Contrary minded. The motion is carried.

MR. RUSSELL: I would like to make a motion that a vote of thanks be extended to the Committee for their work. They have worked practically 2 years and put in a great deal of time. I know that this work is going to be of considerable value to all the members of the Institute. It is a short way to dispose of it in a few minutes' discussion, but the book itself represents a great deal of work on the part of some eight or ten chemists, covering the last 2 years, in addition to the work which Mr. Fulweiler himself put on it some time ago.

MR. FULWEILER: I would like to say that I regret exceedingly that there is one portion of this report I did not read.

"I also wish to express my appreciation of the efforts of Mr. A. F. Kunberger, who was appointed editor of the Handbook since the last meeting of the Institute, and upon whose shoulders has devolved most of the work in connection with getting into suitable form for publication the data secured by the Committee."

I can testify from my own personal knowledge that Mr. Kunberger certainly deserves any of the thanks that are being handed about for committee work, for he has worked most faithfully, long and strenuously in getting this in shape, and nobody fully appreciates that unless they could see the data come in and know what the work consisted of. I would like to second that motion of Mr. Russell's, with that included.

THE CHAIRMAN: You have heard the motion which has been seconded. All in favor please signify by saying aye. Contrary minded no. The motion is carried. I think none of us will be able to appreciate the work until we have studied over it for years. It will probably be a long time before a valuable committee report such as this will be fully appreciated, as is usually the way with a fine piece of work.

I believe we have a report from Professor White, representing the Nominating Committee.

PROFESSOR WHITE: I was not aware that I was to make a report, but then I think I can remember what it was to be.

THE CHAIRMAN: If you will, please.

PROFESSOR WHITE: The Committee appointed to nominate three members from this Section, one of whom shall be selected by the Institute Nominating Committee for next year, recommend that the three nominations be Mr. M. E. Mueller, of New York, Mr. R. B. Harper, of Chicago, and Mr. Leon B. Jones, of San Francisco, Cal.

THE CHAIRMAN: Gentlemen, you have heard the report of the Committee. What is your pleasure?

MR. RUSSELL: I move it be accepted.

THE CHAIRMAN: Is there any second to that motion?

MR. FULWEILER: Second the motion.

THE CHAIRMAN: It has been moved and seconded that the report of the Committee on Nominations for Vice-President of the Chemical Section for next year be accepted. All in favor please signify by saying aye. Contrary. Carried.

The next on the program is a paper entitled "A Study of Gas Oils," by Mr. R. C. Downing and Mr. E. F. Pohlmann. The paper will be read by Mr. Downing.

A STUDY OF GAS OILS.

In order to insure the most economical use of oil in carbureted water gas manufacture it is of prime importance that an extensive study be made of oils themselves, as well as of the conditions which affect their utilization. The need of such an investigation at the present time is paramount, because of the existing high prices in the oil market. The adoption of numerous new processes for the production of gasoline has exerted a detrimental influence on the quality of gas oils, and impaired their efficiency as enriching mediums for water gas. While much has been written concerning petroleum oils and hydrocarbons in general, the literature which serves as an aid in the practical identification and valuation of gas oils is very scant. This paper is an attempt to summarize items of useful chemical knowledge pertaining to gas oils, as well as to present some interesting conclusions regarding their action under the influence of heat, which have been derived from tests made during the past few years. It will be divided into two parts. Part I consists of a discussion of the various physical and chemical tests applied to gas oils. Part II deals with the influence of different gaseous atmospheres on the decomposition of oils, and the probable changes relative to their decomposition.

PART I.

It is believed advisable at the outset to call attention to the various physical tests which may be of value in obtaining a better understanding of oils in general. Briefly they may be summarized as follows:

A. *Physical Constants:*

- Color.
- Odor.
- Specific Gravity.
- Refractive Index.
- Surface Tension.

Viscosity.
Flash and Burning Points.
Heating Value.
Fractional Distillation.

B. *Chemical Characteristics:*
Ultimate Analysis.
Sulphur Content.
Absorption with Sulphuric Acid.
Absorption with Fuming Sulphuric Acid.
Bromine Number.
Formolite Number.

The great difficulty in making use of these various tests lies in the fact that a basis of comparison is not usually available. One does not always know how a given oil has behaved under operating conditions, although considerable time may have been spent in analyzing such an oil. However, when it is possible to actually decompose or gasify the oil on a small scale in the presence of blue gas, the sperm and heating value of the gas made, together with the quantity produced, furnish an excellent idea of the value of the oil. In addition to this, a basis is provided with which it is possible to compare and determine the value of the other tests made on the oil.

It is essential that when such a basis is employed that the laboratory device used should give results somewhat comparable to those obtained in practice. The temperature of cracking, time of contact of the oil vapors with the heated walls, size of the apparatus, amount of oil used per thousand cubic feet of gas made, and the quality of blue gas used all exert a considerable influence on the result obtained. The failure of different investigators to consider all of these conditions has resulted in a wide range of results. The data presented in this paper was obtained by using a 2-inch tube as the cracking medium, heated uniformly over a length of 42 inches.[1]

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[1] *Proceedings*, Illinois Gas Association, 1916, p. 53.

The oil cracked was of the mid-continent type, the analysis of which is shown under the heading K in Table I. This oil was introduced into the cracking tube at the rate of 5 gallons per 1,000 cubic feet of gas made. At this rate the time of contact of the oil vapors in the machine approximated 5 seconds.

Chart I is an illustration of the apparatus used. The method of operation was briefly as follows: Blue gas was made by passing steam through a bed of finely crushed coke, contained in an iron pipe and heated to incandescence in the furnace *A*. *B* is the storage holder for the blue gas, from which it is drawn into the smaller holder *C*. Here the pressure can be increased sufficiently to force the blue gas at the desired rate of 0.2 cubic foot per minute through the cracking furnace *F*, the scrubbing apparatus *G*, and the meters *D* and *H*. The temperature of the furnace *F* can be accurately controlled, and measurements made with pyrometer fire ends situated at four points along the tube. Oil is introduced into this cracking tube from the glass burette *E*, at the regulated rate of 5 cubic centimeters per minute. The finished gas is scrubbed with beads and cotton, metered and then passed into the small holders *I*, from which it is sampled and tested after storage for 1 hour. Since both the blue gas and finished gas were metered, the difference between the two at the end of the run furnishes a correct indication of the volume of oil gas made.

Candle-powers were taken using the pentane lamp as the standard, and the No. 7 Bray L. P. slit union burner for testing the gas. Analyses were made with the Morehead burette, palladium black being used to absorb the hydrogen. The specific gravity was taken with Schilling's apparatus. Heating values were obtained with the Junker's gas calorimeter.

Experience has shown it to be possible to obtain results in the laboratory which do not vary more than 5 per cent. from the values obtained at the works. Furthermore, duplicate tests on the same oil always agreed within less than 1 per cent. when the proper precautions were taken. In view of these facts considerable reliance may be placed on the cracking data, as furnishing a correct means of valuating gas oils. However, as it would be impossible for many laboratories to employ such a device for testing oils, a study has been made of the more common and simple tests usually applied to them, with the end in view of furnishing an intelligent basis of interpretation. The following are some of the conclusions reached.

Color.

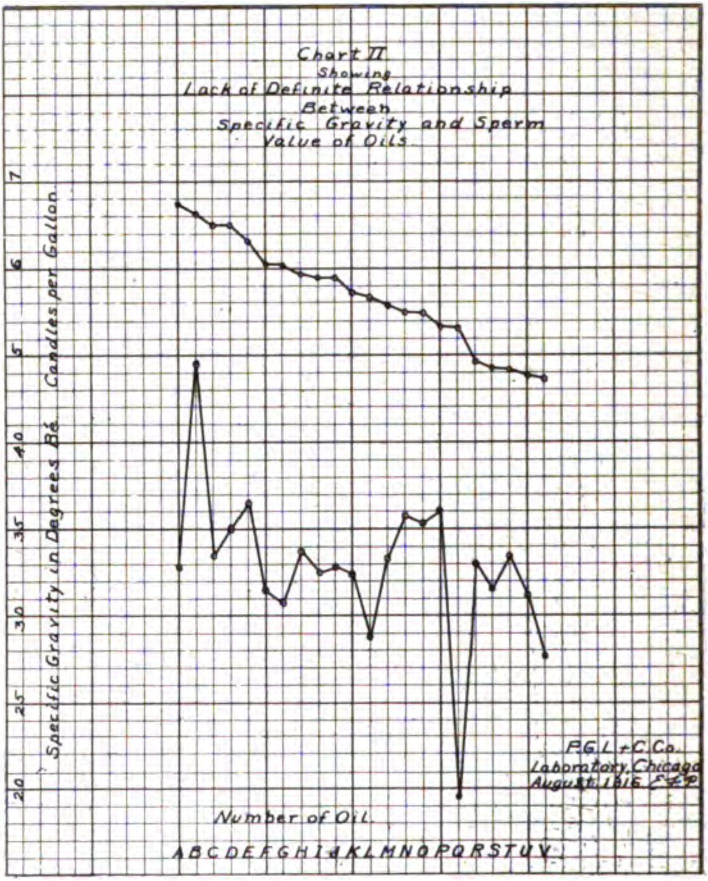
The color of an oil offers but little indication as to its real characteristics. Western oils, from California, Texas and Mexico are usually black in color. Eastern crudes possess a lighter color. The process of refining produces great changes in appearance and the fractions may be entirely different from the original oil. Clear oils have usually been refined considerably. Light colored oils, as a rule, are fairly good for gas making purposes. They apparently have not been cracked to such a great extent as some of the darker oils. On the other hand some oils of a light color have been encountered which contained considerable portions of low boiling fractions of an inferior nature which decrease their value.

Odor.

Besides observing the color of an oil sample, the chemist usually notes the odor. This may be sweet, mild, pungent or offensive. The latter odors indicate a high amount of sulphur. Most gas oils, however, have a somewhat disagreeable smell and the odor furnishes no more real indication of value than color. Gas oils that have been cracked during the process of refining usually possess a slight aromatic odor which can be detected by an experienced observer.

Specific Gravity.

Formerly specific gravity was the only criterion by which an oil was judged. It is now generally known that this characteristic can not be depended upon to furnish the required knowledge. The specific gravity is a useful figure as an aid in calculation of various works results, and as a quick test to determine the character of oil shipments.



When an oil is distilled under vacuum and the various fractions gasified, the high boiling or heavier gravity portions will usually yield the best results. In general, for a given boiling point, the lower the gravity the better will be the quality of the oil. Gravity results are listed in Table I, Column 3, and their relation to the sperm value of the oil is shown in Chart II. It will be readily seen that no definite relation exists.

However in testing several oils of different specific gravity which were obtained from the same crude stock, it was noticed that the higher gravity or lower Baume degree oils were of slightly better quality. This is no doubt due to the fact that a gallon of oil contains a greater weight of valuable constituents.

Refractive Index.

The refractive index has been considered by some as an aid in discriminating between oils. In his researches connected with the production of gasoline, Rittman[2] has investigated the physical characteristics of numerous oils. His conclusion concerning the refractive index is that it varies proportionately with the gravity and offers no additive information to that which the gravity test supplies.

Surface Tension.

Surface tension of various oils was also investigated by the Government and was found to be affected to a great extent by small amounts of impurities in the oil, so that the results of this test can not be relied upon. Surface tension may prove of use in the examination of asphalts and petroleum residues, which are intended for road building purposes. There does not seem to be much logical relation between this test and the gas making value of an oil.

Viscosity.

Viscosity tests are of course of prime importance in the valuation of lubricating oils. When applied to gas oils, this test is only useful in indicating the ease with which they may be handled in the pumps. A high viscosity gas oil will frequently cause trouble in cold weather when unloading cars and necessitate the use of steam coils. Column V of Table I contains the results of a few tests made on the viscosities of various oils, and it will be seen at a glance that no relation exists between viscosity and the actual efficiency of cracking. The determinations given were made on the Scotts Viscosimeter. A viscosity greater than 4 at 60° F. indicates that difficulty will be encountered in transporting the oil through exposed pipes in cold weather.

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[2] *Bulletin No. 114*, U. S. Bureau of Mines, p. 90.

The cold test is also useful in determining whether the oil will flow in cold weather and should be made on oils which contain a large percentage of higher boiling paraffine waxes or asphalt.

Flash and Burning Points.

Table I also contains the various flash and burning points of oils, as shown in Column VI. These determinations were made with the open tester. No uniformity exists between the flash point and enriching value. The flash and burning point determination is necessary from the standpoint of safety. An oil which flashes below 170° F. is frequently regarded as unsafe, although oils with much lower values have been successfully stored by gas companies. The efficiency of oil refiners in extracting gasoline usually results in present day gas oils possessing safe flash and burning points.

Heating Values.

The heat value or B. t. u. per pound of gas oil has been advocated by some authorities as a possible means of ascertaining its value. The committee of the Dutch Gas Managers Association[3] on the testing of gas oils reported in 1912 that the quality of an oil is probably proportional to the heating value. They were not able to determine at that time whether the B. t. u. test was sufficiently accurate to discriminate between the quality of oils of similar type.

On the other hand Sherman and Kropp[4] report that the

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[3] *Journal of Gas Lighting*, July 23, 1912, p. 247.

[4] *Journal of Gas Lighting*, Aug. 29, 1911, p. 543.

TABLE I.

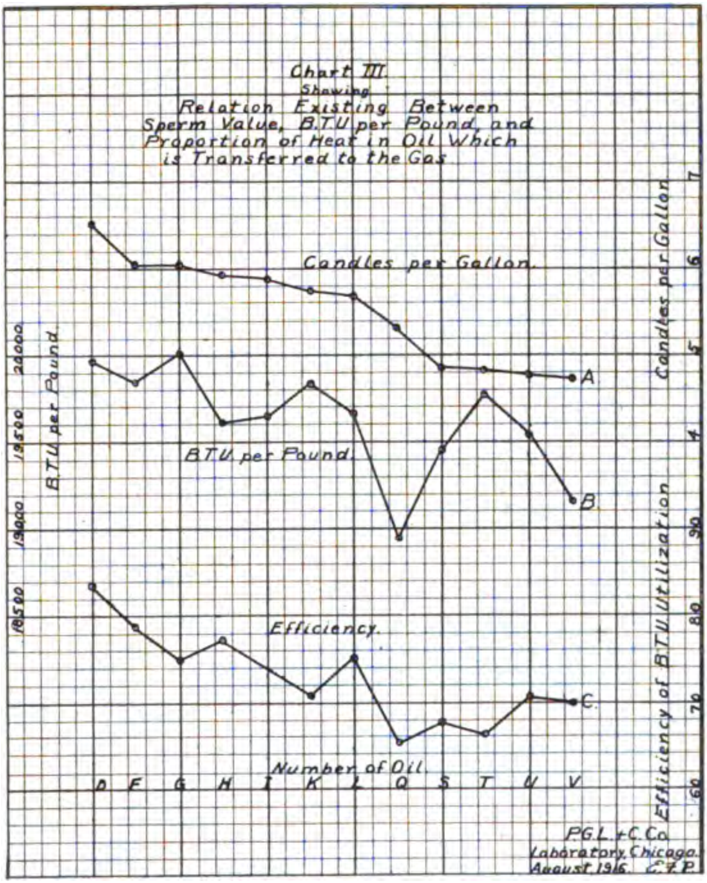
RIOUS OILS TESTED.

s	IX Unsaturated with Sulphuric.	X Unsaturated and Aromatic with fuming Sulphuric.	XI Bromine Numbers. Addition	 Substitution	 Total.	XII B.T.U. per Pound.	XIII Per Cent Sulphur.	IXV Cracking Results at 5 Gal. per M. Candles per Gallon.	 B.T.U. per Gallon.	 % Gas.	 % Tar.	 % Carbon	 Candles per Pound.	 B.T.U. Efficiency %.
	0	0	0	0	0	—	0	6.72	125800	70.6	17.9	11.5	1.177	—
—	5	8	—	—	—	—	—	6.62	114200	71.8	22 9	5 3	.992	—
.71	25	27	—	—	—	—	0 15	6 50	114800	72.3	20 5	7.2	.911	—
	16	24	13.48	3.57	20.62	19967	0.11	6.49	118000	73.0	16.5	10.5	.821	83.5
.71	6	11	1.35	7.7	16.75	—	0.28	6.33	114200	67.3	21.2	11.5	.902	—
.40	23	28	10.31	1.88	14.07	19842	0.14	6.04	112800	69.1	19.0	11.9	.836	78.7
.20	32	43	8.84	3.57	16.74	20031	0.36	6.04	108800	59.0	21.6	18.4	.832	74.8
.48	31	36	28.40	10.61	49.61	19605	1.66	5.94	107500	68.6	26.6	4.8	.833	77.0
.67	27	29	12.86	4.52	21.90	19645	0.11	591	—	62.0	26 1	11.9	.824	—
48	14	17	.9	3.38	6.85	—	0.22	5.91	110700	65 0	28.7	5.3	.825	—
.21	20	28	6.25	5.94	18.13	19831	0.26	5.73	100750	59.2	30.3	10.5	.800	70.9
01	15	20	—	—	—	19668	0.25	5.66	108000	62.9	26.9	10.2	.771	74.8
07	22.5	34	—	—	—	—	1.99	5.54	100000	61.4	32.6	6.0	.776	—
.57	21	28	7.15	10.91	28.97	—	1.78	5.48	107200	57.5	28.4	14.1	.778	—
.51	20	30	—	—	—	—	1.97	5.46	107000	59.7	30.7	9.6	.773	—
82	8	19	9.12	2.77	14.66	—	—	5.37	—	65.7	28.1	6.2	.766	—
95	85	—	—	—	—	18943	0.68	5.32	86500	52.7	33.5	13.8	.682	65.3
.81	15	24	—	—	—	—	—	4.81	—	52.2	31.5	16.3	.686	—
09	16	29	5.65	8.09	21.83	19462	0.26	4.85	95200	57.4	31.4	11.2	.672	67.8
.03	18	30	—	—	—	19772	0.25	4.82	93400	57.8	35.0	7.2	.676	66.2
.64	16	28	3.76	8.28	20.32	19541	0.17	4.79	97600	57.3	33.7	9.0	.661	70.4
.51	16	28	3.3	8.65	20.50	19184	0.32	4.75	101400	55.9	35.3	8 8	.642	70.1
	—	—	—	—	—	—	—	0 99	30220	18.8	71.0	10 2	—	—
6.0	—	—	—	—	—	—	—	0.27	—	9.5	64.8	25.7	—	—

heating value of an oil varies with the gravity. They state that the formula

$$\text{B. t. u. per pound} = 18{,}650 + 40(\text{Be}^\circ - 10)$$

gave results within 1 per cent. of actual or determined value on more than 60 oils tested. This being true it is evident that



the B. t. u. test can not be relied upon to furnish an idea of the enriching value, since the gravity itself is no indication.

Tests made in The Peoples Gas Light & Coke Company's

Laboratory on about a dozen oils, are listed in Table I and Column XII. The Mahler bomb calorimeter was used. These tests also show a similar relation between the specific gravity and heating value to that found by Sherman and Kropp. For the sake of convenience, these results have been transferred in curve form to Chart III, where comparisons are made with the sperm value. It will be noted that high B. t. u. oils gave good candle per gallon values when gasified. However, some relatively low B. t. u. oils also furnished good results. It is again apparent from this data that no definite relationship appears to exist between the B. t. u. and the enriching value of oils.

This failure of the B. t. u. results to indicate the gas making quality of an oil is no doubt caused by the different rate of decomposition of oils when exposed to heat. Some oils will decompose rapidly to carbon and it is evident that more heat units are lost to the gas in this case. From the curves *C* on Chart III, it will be noted that the efficiency of utilizing the B. t. u. in the oil varies from 85 to 65 per cent. The nature of the chemical combination of the constituents of the oil, which possess no particular relation to the heating value, is doubtless the cause of this variation in efficiency.

Fractional Distillation.

Next to specific gravity fractional distillations have been relied on in the past to indicate the value of gas oils. For use as an aid in gas manufacture it is convenient and sufficiently accurate to collect fractions of an oil which have distilled over each 100° F., up to 700° F., or if necessary until no more distils off. Generally speaking the fractions become more valuable as the temperature at which they distil over becomes higher. This is especially true when the fractions increase in volume up to 700° F. With some oils, when the maximum distillate comes over at some intermediate temperature between 400° to 600° F., and then rapidly decreases, the higher boiling fractions have been found to be inferior.

Again the specific gravity of the distillation fractions are important in determining their relative values. For a given boiling point the value increases with a corresponding decrease in the specific gravity of the fraction. The reason for this is evident when comparisons are made between specific gravities of compounds of the different chemical series having the same boiling point. In Chart V, the boiling points and specific gravities of some compounds which occur in petroleums are listed. It will be noted that paraffine compounds are the lightest and are followed respectively by the olefins, naphthenes and aromatic compounds. It is now an established fact from a gas-making standpoint that paraffine oils rank first as to their enriching value, olefines are slightly inferior and are followed by naphthenes. Aromatics are decidedly inferior.

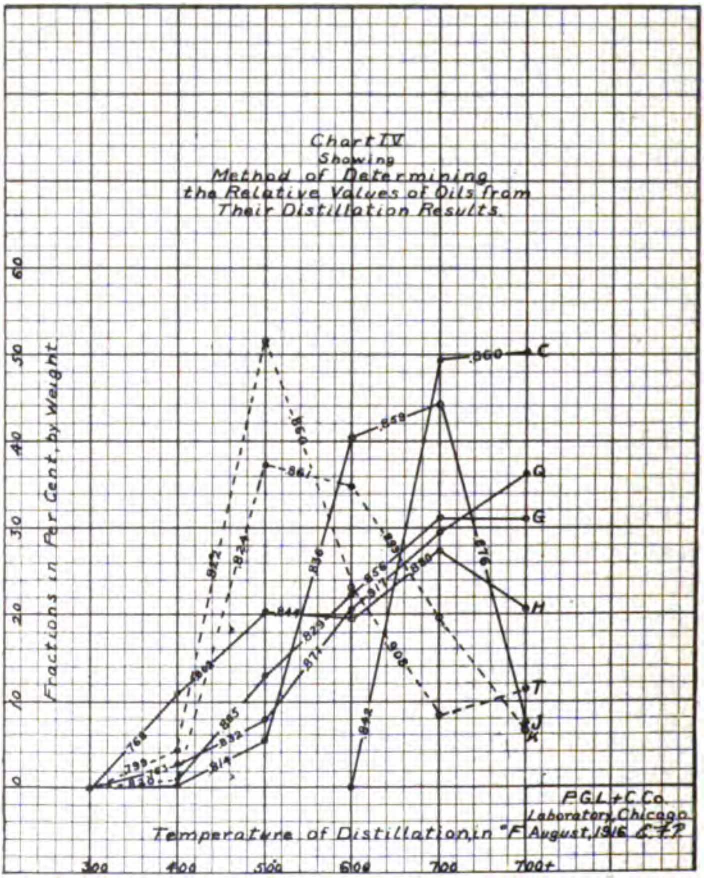
The above principle may easily be applied in interpreting distillation results. As an illustration, the curves of several oils are shown on Chart IV. Oil *C* is a high boiling point transformer oil. This oil gave very good results in cracking. The comparatively low gravities of these high boiling portions should be noted.

Oil *G* is from the Texas field, *H* is a Mexican oil and *Q* is from California. These oils show very similar results when distilled, and the distillation curves are of a distinctly different form from those of the other gas oils. The gas-making value of these oils vary according to the alphabetical order in which they have been arranged. For any given fraction, the gravities of curve *G* are lower, those of *H* are intermediate, while those of the California oil *Q* are much the heavier.

Oils *J* and *K* are both from the mid-continent field. The larger percentage and lighter gravities of higher boiling fractions of *J* would indicate it to be the better of the two. The candles per gallon values obtained in cracking were 5.91 and 5.73 respectively.

Oil *T* is also a mid-continent oil. The large portion distilling over between 400° and 500° F. appears to be an indication of inferiority since this gave only 4.82 candles per gallon, when cracked. When kerosene is added to gas oils the effect would be to increase the fraction boiling from 400°

to 500° F. Kerosene itself yields excellent results when cracked. A sample of commercial kerosene gave 6.62 candles per gallon. From the principles stated concerning the value



of oils with low boiling points and high gravities one might expect lower results with this oil. Kerosene, however, consists almost wholly of saturated or paraffine compounds while the lower boiling fractions of some gas oils contain a large percentage of unsaturated compounds. This fact may account for the apparent inconsistency noted.

A good gas oil should show less than 2 per cent. of coke, when the distillation is carried far enough to obtain carbon residues. Furthermore, if the fractions vary widely and the oil is composed of large portions of low boiling compounds, with a correspondingly large amount of high boiling compounds, it is not to be expected that as good results will be

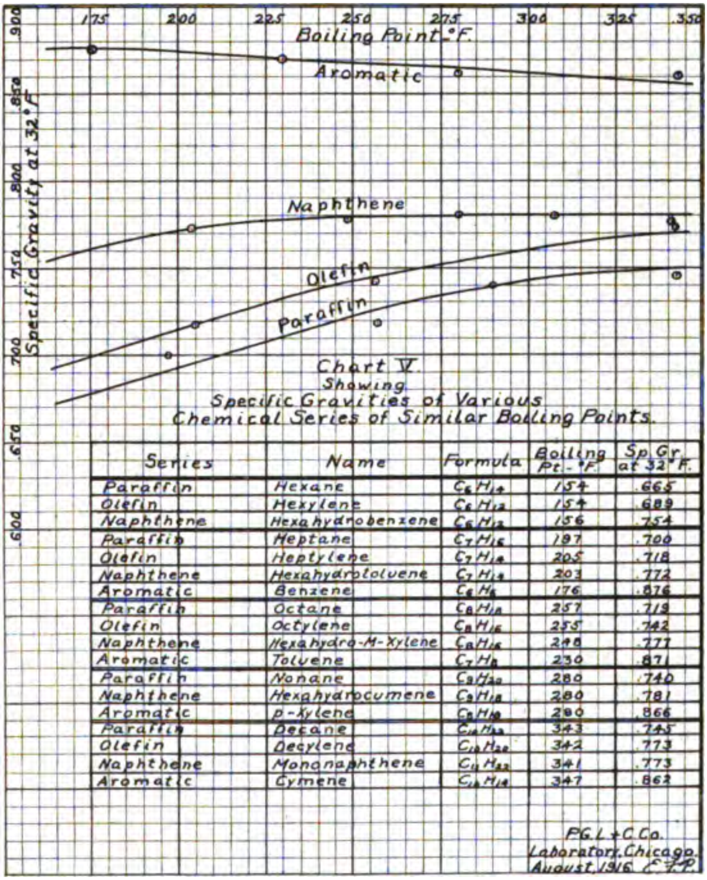


Chart V.
Showing
Specific Gravities of Various
Chemical Series of Similar Boiling Points.

Series	Name	Formula	Boiling Pt.-°F.	Sp. Gr. at 32° F.
Paraffin	Hexane	C_6H_{14}	154	.665
Olefin	Hexylene	C_6H_{12}	154	.689
Naphthene	Hexahydrobenzene	C_6H_{12}	156	.754
Paraffin	Heptane	C_7H_{16}	197	.700
Olefin	Heptylene	C_7H_{14}	205	.718
Naphthene	Hexahydrotoluene	C_7H_{14}	203	.772
Aromatic	Benzene	C_6H_6	176	.876
Paraffin	Octane	C_8H_{18}	257	.719
Olefin	Octylene	C_8H_{16}	255	.742
Naphthene	Hexahydro-M-Xylene	C_8H_{16}	248	.777
Aromatic	Toluene	C_7H_8	230	.871
Paraffin	Nonane	C_9H_{20}	280	.740
Naphthene	Hexahydrocumene	C_9H_{18}	280	.781
Aromatic	p-Xylene	C_8H_{10}	280	.866
Paraffin	Decane	$C_{10}H_{22}$	343	.745
Olefin	Decylene	$C_{10}H_{20}$	342	.773
Naphthene	Mononaphthene	$C_{11}H_{22}$	341	.773
Aromatic	Cymene	$C_{10}H_{14}$	347	.862

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obtained as in the case where the bulk of the oil has substantially the same boiling points within a small temperature range. The heavy or high boiling compounds are more complex and are more easily decomposed. In general they crack more efficiently at lower temperatures, while the simpler or less complex light oils decompose more efficiently at slightly higher temperatures.

Ultimate Analysis.

As yet but little study has been made as to the value of an ultimate analysis in rating gas oils. That there is a possibility of this determination becoming useful is evident from a consideration of their chemical composition. Gas oils consist chiefly of the six series.

Paraffine	C_nH_{2n+2}
Polymethylene or naphthene	C_nH_{2n}
Olefine	C_nH_{2n}
Acetylene	C_nH_{2n-2}
Asphaltic	C_nH_{2n-4}
Aromatic	C_nH_{2n-6}

It has already been stated that the paraffine compounds are superior to the others. They are also more fully hydrogenated and are therefore more capable of decomposing with the formation of larger amounts of methane and illuminants. It would seem that the higher the hydrogen content of an oil the better the cracking results obtained. The ultimate analysis is rather difficult to perform and will never find favor as a quick test. No study has been made of ultimate analysis in connection with the other tests of this paper, so we are in no position to pass on the real merits of this kind of analysis. From what other investigators have done, however, and from actual analysis of different types of oils found in this country, it appears that the considerations based on ultimate analysis do not apply. The analyses of some principal type oils have been listed by J. L. E. Cheetham.[5] The data given in regard to hydrogen content furnishes no consistent and definite means of discrimination.

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[5] *American Gas Light Journal*, Sept. 20 1909, p. 725.

Sulphur.

Sulphur determinations on an oil are easily and quickly made when an oxygen bomb calorimeter is available. This determination is very useful in that it provides information as to the burden the purifying boxes will be obliged to carry. From a number of oils tested it has been observed that about 40 per cent. of the sulphur in the oil appears in the gas as hydrogen sulphide, the remainder combining with the tar. Although oils with as high as 2 per cent. sulphur are used in some plants, the usual content should be less than 0.3 per cent.

It appears probable that sulphur in the oil contributes to a greater formation of tar. To clear up this point, a gas oil was mixed with 10 per cent. of carbon bisulphide and cracked in the usual manner. No appreciable difference in the amount of tar formed was noticed, while the hydrogen sulphide produced was extremely high. It is possible that sulphur dissolved in the oil, instead of carbon bisulphide, might give different results, but this has not been tried as yet.

As the temperature of cracking increases, more of the sulphur appears in various forms in the tar, and less hydrogen sulphide is found in the gas. This may be due to the fact that greater gas and less tar volumes are formed at high temperatures.

Sulphonation.

As a result of considerable research on oils Ross and Leather[6] conclude that:

(1) Open chain hydrocarbons have the best value for gas making.

(2) The presence of double bonds in the chain slightly reduces the value.

(3) The presence of one or more rings considerably reduces the value.

It is therefore evident that a method which determines the portion of paraffine, unsaturated and aromatic compounds, should be of value in rating oils. When an oil is mixed with sulphuric acid the olefine and acetylene compounds are attacked and sulphonic acids formed. Fuming sulphuric acid acts upon the aromatic compounds and if of the proper strength will not attack the paraffines. This principle was applied with the hope of obtaining a quick and valuable test. The sulphonations were made in Babcock milk testing bottles. A modification of the U. S. Forest Products Laboratory method for sulphonation of creosote oils was employed. Only 2 cubic centimeters of the oil were used. This was necessary because of the high amount of paraffines present in gas oils. A 37/N solution of sulphuric acid was used to obtain the aromatic and olefine compounds. Another sample was treated with concentrated sulphuric acid of 1.84 specific gravity, to obtain the olefines and acetylenes. The results of the tests appear to be somewhat irregular, although they yield some information of value. The amount of olefines and unsaturated compounds found with sulphuric acid was not an indication of the real value. Many of the oils had already been refined with sulphuric acid, especially the clear or light colored ones, and gave low sulphuric acid absorptions. Some of the inferior oils showed a higher proportion of aromatic compounds. These oils are known to be heavily cracked, the product from a pressure still. Texas and Mexican oils also contained large portions of unsaturated and aromatics, but yield good cracking results. By comparing the results of sulphonation with the distillation analysis, it is possible that quite definite conclusions can be drawn concerning the relative values of the oils. Chart VI shows the relation between the proportion of the various compounds and the enriching value. The larger percentage of aromatic compounds in the inferior oils is to be noted.

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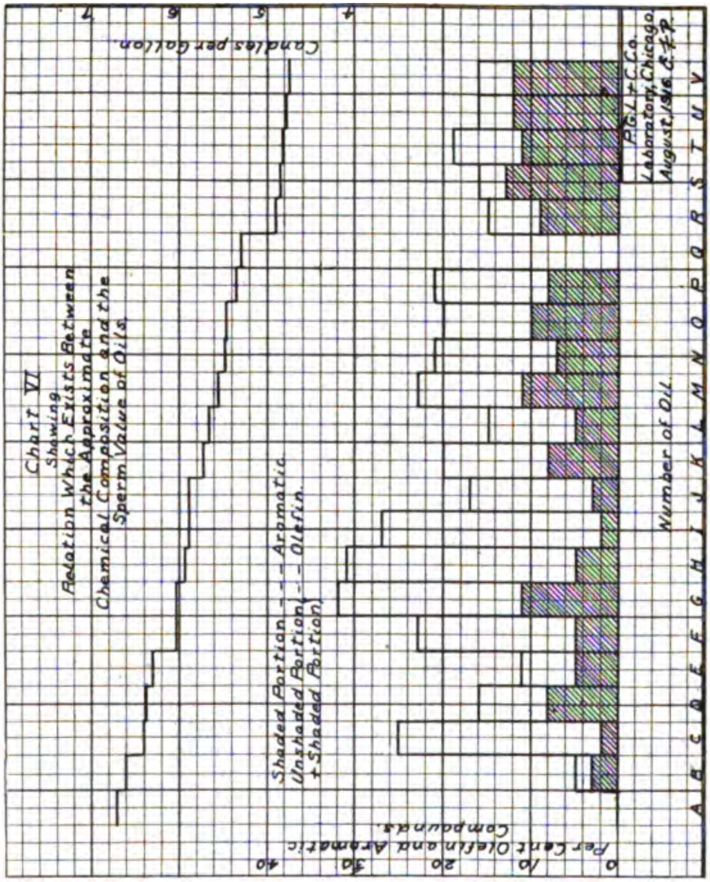
[6] *Journal of Gas Lighting.*, Sept. 25 1906, p 325.

Bromination.

Another well-known method of differentiating oils is by bromination. Bromine acts upon unsaturated compounds forming addition products. It also acts upon the aromatic constituents forming substitution products and hydrobromic acid. In the dark, or diffused light, paraffines and naphthenes are not attacked. The method of conducting the test is fully discussed by Park and Worthing in the Institute PROCEEDINGS.[7] The authors have not demonstrated the value of this method,



however, since they did not make direct comparisons between the bromine numbers and the actual sperm value of the oils tested. Column XI of Table I contains the bromine numbers of some of the oils tested. These results are also shown graphically in Chart VII.

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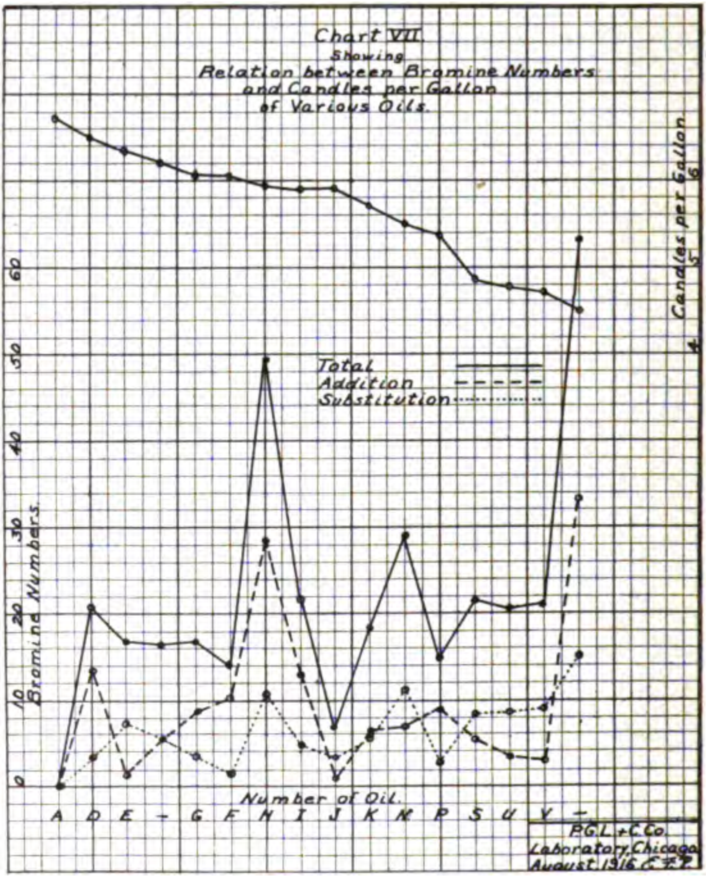
[7] *Proceedings American Gas Institute*, 1909, p. 487.



The general rules to be applied in determining the value of oils from bromination results are as follows:

(1) Oils with low total bromination numbers should be the best, because such a low number indicates a high percentage of paraffines.

(2) Large substitution numbers denote the presence of aromatic compounds and oils with large substitution numbers are usually of inferior quality for gas making.

(3) The addition number indicates the percentage of unsaturated compounds present. Some of the olefine and other unsaturated oils will decompose under the influence of heat almost as efficiently as the paraffines, so it does not necessarily follow that oils with high addition numbers are of an inferior grade.

The results of bromination should be somewhat similar to the values obtained by sulphonating oils. Each test gives an approximate idea of the amounts of the various chemical series present. The bromine numbers are more difficult to obtain and require very careful chemical manipulation. The results as shown in Chart VII are compared with the values obtained by cracking. It will be noted that no definite conclusions can be drawn from these bromine numbers as to the value of the oils. The probabilities are that the inconsistencies in the results are caused by the impurities present. High percentages of sulphur in the oil will cause the bromine numbers to be high. The two Mexican oils tested containing more than 2 per cent. of sulphur give abnormally high bromination absorptions. From the data obtained it appears certain that bromination, as an individual test to determine the quality of oils, can not be depended upon.

Formolite Number.

Nastjukoff[8] has shown that when oils are treated with sulphuric acid and formaldehyde, a brown precipitate is formed which he called formolite. The formolite number obtained from the weight of this precipitate is a measure of the cyclic unsaturated compounds in an oil. The method has been modified by Richardson[9] and the results he found differ but slightly from those obtained by sulphonation with fuming sulphuric acid. This method was tried but found very tedious and diffi-

[8] *Journal Society of Chemical Industry*, vol. 23, 1904, p. 1082.

[9] *Journal Industrial and Engineering Chemistry*, April 1916, p. 319.

cult to operate. The results obtained were not promising enough to justify further work on this line.

The foregoing discussion of methods which may be used for evaluating gas oils has demonstrated the difficulties which will be encountered in arriving at correct conclusions. Much experience and good judgment are required to properly place an oil. The cracking test is the most definite in its results. Furthermore, such a test can easily be conducted in 6 hours and is well worth the time spent on it, because of the additional information which can be procured concerning the proper temperature of carbureting.

PART II.

The investigation of the effect of various gaseous atmospheres upon the results of cracking, was undertaken with the object of determining the influence of each constituent of the blue gas upon the quality and quantity of the end products produced. In order to make comparisons special care was taken to maintain the time of contact approximately the same with each gas used.

The atmospheres used were as follows: nitrogen, carbon dioxide, carbon monoxide, hydrogen, methane, blue gas and a mixture of blue gas with 10 and 20 per cent. of steam respectively.

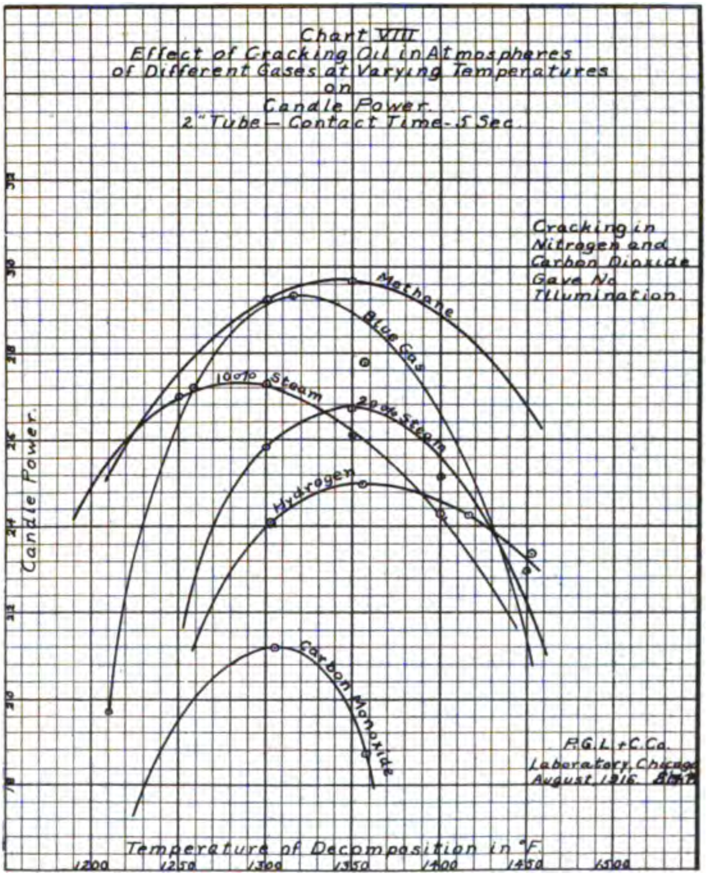
Preparation of Gases.

Nitrogen was obtained by burning phosphorus in a large bell jar over water. When the combustion was complete the residual nitrogen was transferred to the holder and the process repeated until sufficient gas was obtained. Only 5 feet of gas was required for the tests, otherwise the cuprous oxide method for preparing nitrogen would have been adopted.

Carbon dioxide was produced by the action of hydrochloric acid on marble chips in a Kipp generator, the gas being washed with water to remove the acid fumes.

Carbon monoxide was made by passing a slow stream of oxygen through a bed of incandescent coke. The same furnace used for the manufacture of blue gas was utilized for this purpose.

The Kipp generator was used in preparing the hydrogen. Hydrochloric acid acting upon granulated zinc produced the desired gas. Scrubbing through a wash bottle containing water removed the acid fumes.



Methane was formed by heating a mixture of two parts of sodium acetate with one part of sodium hydroxide in an iron retort. This gas contained some illuminants, which necessitated washing through sulphuric acid.

The blue gas used in these tests, was prepared by passing steam through a bed of incandescent coke at a rate sufficient to insure good decomposition. The furnace is shown in Chart I.

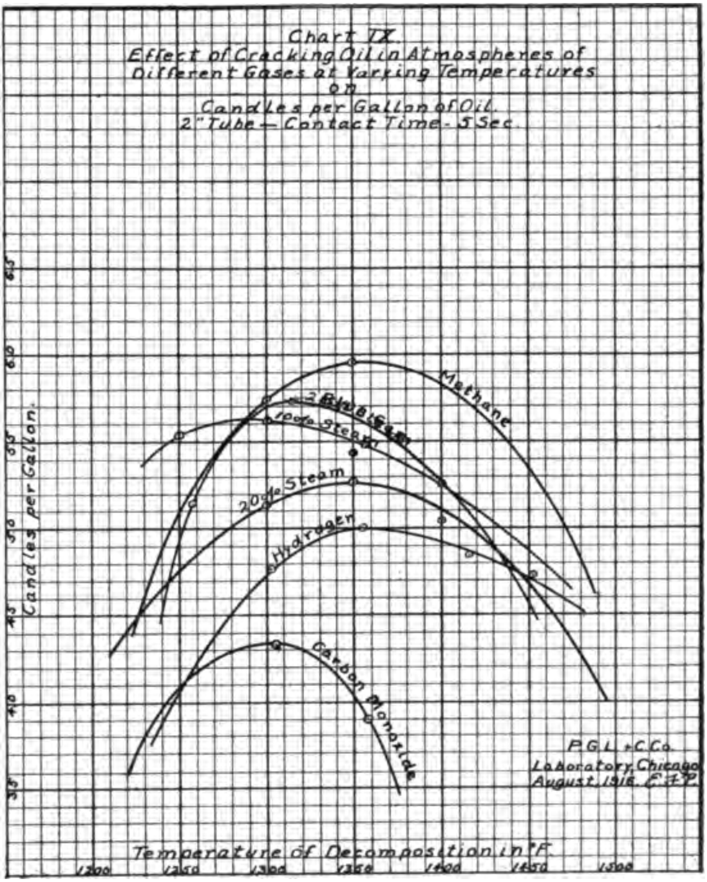
The proper proportion of steam was introduced with the blue gas by means of a flash boiler. This consisted of a 2-inch short nipple capped at both ends. The upper cap contained an inlet, through which water was introduced from a burette, and an outlet leading to the cracking furnace. When the bottom of the flash boiler was heated to a dull red the rate of steam generation could be closely regulated by properly adjusting the burette cock. Knowing the amount of water introduced, in proportion to the oil and the blue gas, it is an easy matter to calculate the percentage of steam and the time of contact.

Analyses of the various gases are shown in Table II. It will be noted that the carbon monoxide, hydrogen and methane, contain considerable amounts of impurities. On the whole, these impurities are probably not sufficient to obscure the main reactions and render the interpretation of results faulty.

TABLE II
ANALYSES OF DILUENT GASES.

	Nitrogen	Carbon Dioxide	Carbon Monoxide	Hydrogen	Methane	Blue Gas
Carbon Dioxide	0.5	95 8	1 4	0.1	0.3	4 6
Illuminants	—	—	—	0 3	1.2	0.4
Oxygen	0.5	0.6	0 6	0 4	0.4	0.4
Carbon Monoxide	0 6	0 2	85 8	0.8	1 6	38.6
Hydrogen	0.6	0.3	5.8	91 2	8.3	50.4
Methane	—	—	2.2	4 6	83.6	1.7
Ethane	—	—	—	—	2 6	—
Nitrogen	97 8	3 1	4.2	2.6	2.0	3.9
Specific Gravity	.9600	1.408	.9190	.1113	.5224	.5415

The results of the tests made with these different atmospheres are contained in Table III and also on the charts following. It is our purpose to consider the effect of each diluent on candle-power, candles per gallon, B. t. u. per gallon and the



production of gas, tar and carbon. Much information concerning the probable cause of the cracking reaction can be also obtained from a study of the gas analysis and production of the various constituents due to the oil, such as illuminants, hydrogen, methane and ethane.

Nitrogen.

The tests were made in nitrogen to determine the effect of a neutral atmosphere. Since nitrogen is very inert, it is reasonably certain that no chemical decompositions other than those similar to the formation of straight oil gas will occur. At the same rate of oil introduction the time of contact will

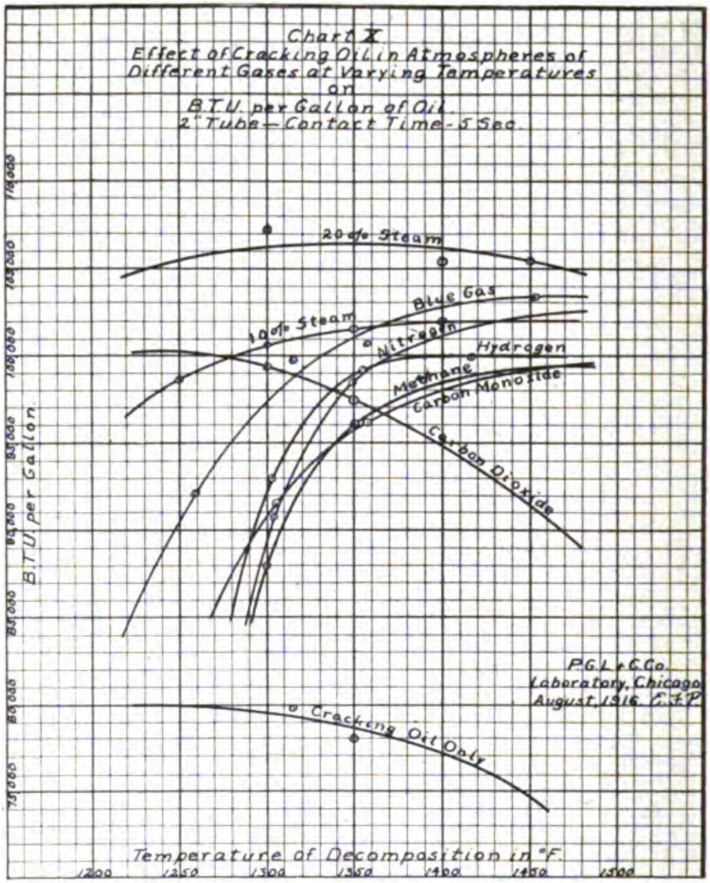


TABLE III.

OF VARIOUS GASES.

Kind	Gas			10% Steam				20% Steam			
Tempera	1315	1357	1452	1250	1300	1350	1400	1300	1350	1400	1450
Cu.Ft.Oi	53.2	56.6	59.8	54.2	56.6	60.4	65.2	59.2	61.8	61.7	66.8
Cu.Ft.To	195.2	198.0	201.8	206.0	205.8	208.0	216.5	198.5	200.7	200.2	206.0
Gallons	5.12	5.05	4.96	4.87	4.86	4.80	4.62	5.04	4.96	4.98	4.85
Candles	5.73	5.48	4.72	5.54	5.62	5.44	5.26	5.14	5.28	5.04	4.73
Per Cent	27.23	28.50	30.2	26.35	27.50	29.0	30.0	29.80	30.7	30.9	32.4
Candle	29.29	27.75	23.39	27.00	27.31	26.12	24.32	25.85	26.22	25.17	23.00
B.T.U.	734	728	721	716	720	715	695	750	755	730	714
B.T.U. per	99800	100756	103300	98700	100700	101600	102000	107200	110700	105500	105500
Per Cent	31.8	30.3	26.0	29.5	24.2	23.9	24.3	20.6	25.6	21.2	20.2
Per Cent	11.4	10.5	17.1	11.2	15.2	18.1	18.3	5.9	5.4	14.8	14.8
Per Cent	56.8	59.2	56.9	59.3	60.6	58.0	57.4	73.5	69.0	64.0	65.0
Hydroge	100	96	85	—	—	—	—	88	87	88	89
Specific	.6760	.6680	.6506	.6749	.6625	.643	.633	.6756	.6474	.6482	.6156
Carbon	3.4	3.6	3.4	2.2	1.8	2.2	1.8	3.2	3.2	3.4	3.4
Illumin	15.4	15.0	13.6	13.6	13.6	13.0	12.2	14.2	14.7	13.7	12.8
Oxygen.	0.3	0.4	0.4	0.4	0.6	0.6	0.4	0.6	0.7	0.8	0.8
Carbon	28.0	27.2	26.6	32.4	32.4	32.5	32.2	28.4	27.4	27.9	26.4
Hydrog	33.5	31.4	29.8	31.6	31.0	28.4	29.5	33.6	30.1	31.6	32.6
Methan	15.0	17.6	23.5	13.2	16.4	19.7	20.9	18.6	18.5	15.3	17.5
Ethane.	2.3	2.5	0.0	3.0	1.5	0.3	0.0	—	1.9	3.5	2.9
Nitroge	2.1	2.3	2.7	3.6	2.7	3.3	3.0	1.4	3.5	3.8	3.6
Constitu											
Cu.Ft. I	30.0	29.8	27.4	27.40	27.37	26.46	25.81	28.2	29.5	27.4	26.4
Cu.Ft. C	+1.4	-0.6	-1.1	-1.51	-0.50	+1.17	+1.50	+0.6	-0.2	+0.9	-0.8
Cu.Ft. H	-6.0	-9.1	-11.4	-8.08	-8.10	-12.10	-9.18	-3.2	-9.1	-6.1	-2.7
Cu.Ft. M	26.8	32.3	44.9	26.00	32.52	39.80	44.04	36.2	36.5	29.6	35.4
Cu.Ft. E	4.5	4.9	0.0	6.18	3.08	0.62	0.0	—	3.8	7.0	6.0
B.T.U. of	2243	2045	2211	2370	2370	2405	2320	2541	2440	2342	2379
Candles	1.90	1.85	1.72	1.98	2.01	2.01	1.99	1.84	1.78	1.83	1.80
Sp.Gr. of	1.273	1.189	1.158	1.200	1.192	1.040	1.025	1.382	1.010	1.010	0.988

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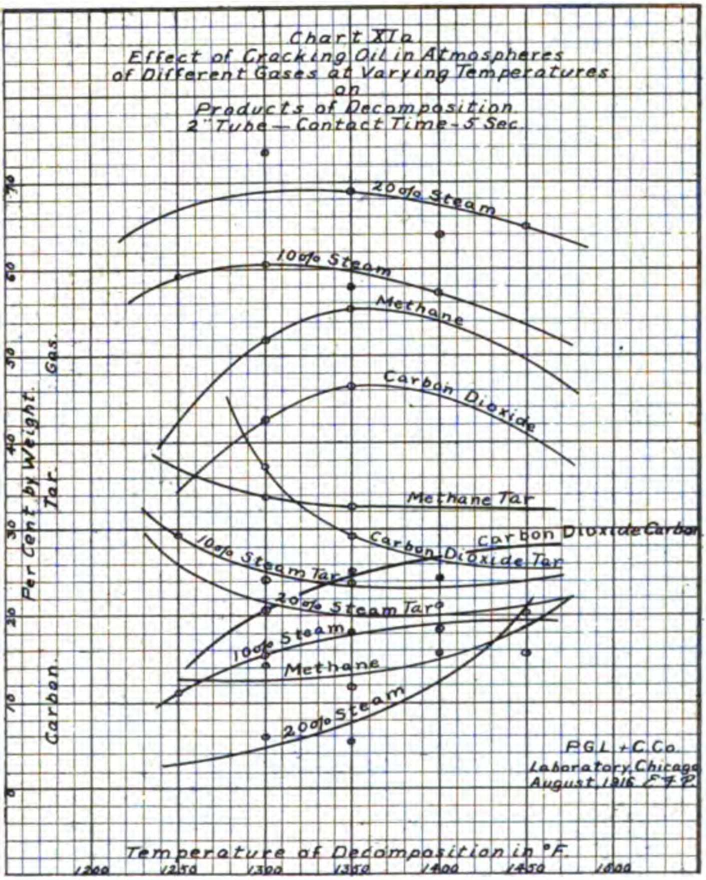
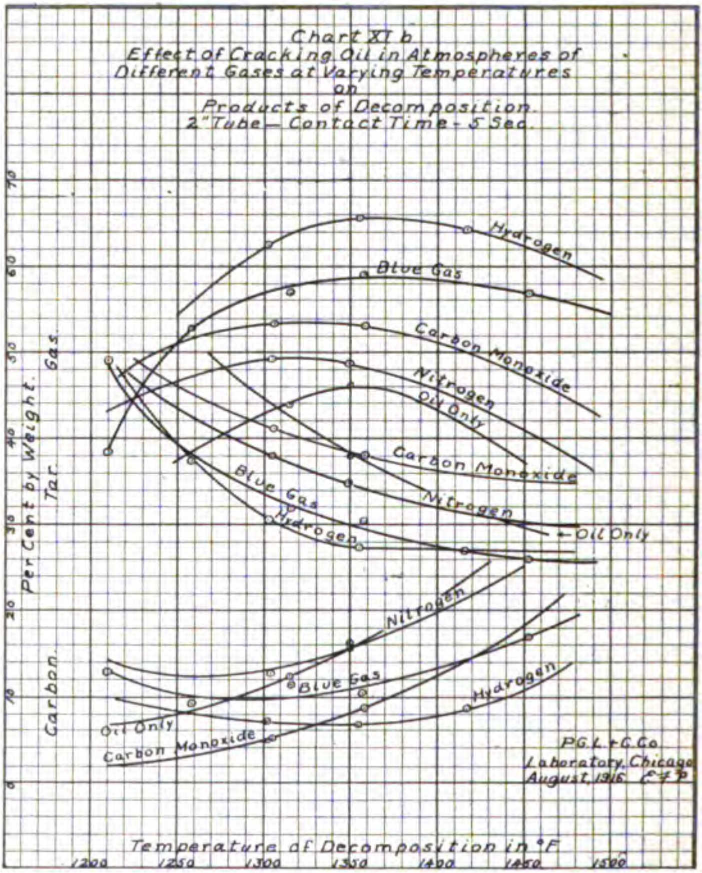
be much less when a foreign gas accompanies the oil vapors through the machine. For example when oil is introduced in to the cracking zone at the rate of 5 cubic centimeters per minute the time of contact will be about 16 seconds. When a carrier for the oil vapors is employed to make the proportion of oil gas in the finished gas about 30 per cent., the time of contact will be about 5 seconds. This will have a material



effect upon results and will be considered under the heading "Oil Only."

No candle-power results could be obtained when the oil was cracked in a nitrogen atmosphere since the gas would not burn in the Bray burner.



The B. t. u. obtained in the gas per gallon of oil (Chart X) is 97,000 at 1,350° F. This is slightly better than that produced in atmospheres of carbon monoxide, carbon dioxide and methane, and lower than that produced in hydrogen and blue gas.

The weight of oil gas produced (Chart XI-*b*) is rather low. This is to be expected since a greater decomposition of the oil gas would take place due to the absence of an active agent to retard such decomposition or to cause hydrogenation.

The tar and carbon produced on the other hand is quite considerable. This is generally the case in inert atmospheres.

The volume of gas made at 1,350° F. is about 62 cubic feet per gallon of oil. It is to be noted also that the production of hydrogen at this temperature is 10.6 cubic feet, whereas when hydrogen is present in the surrounding atmosphere a disappearance or absorption occurs.

Oil Only.

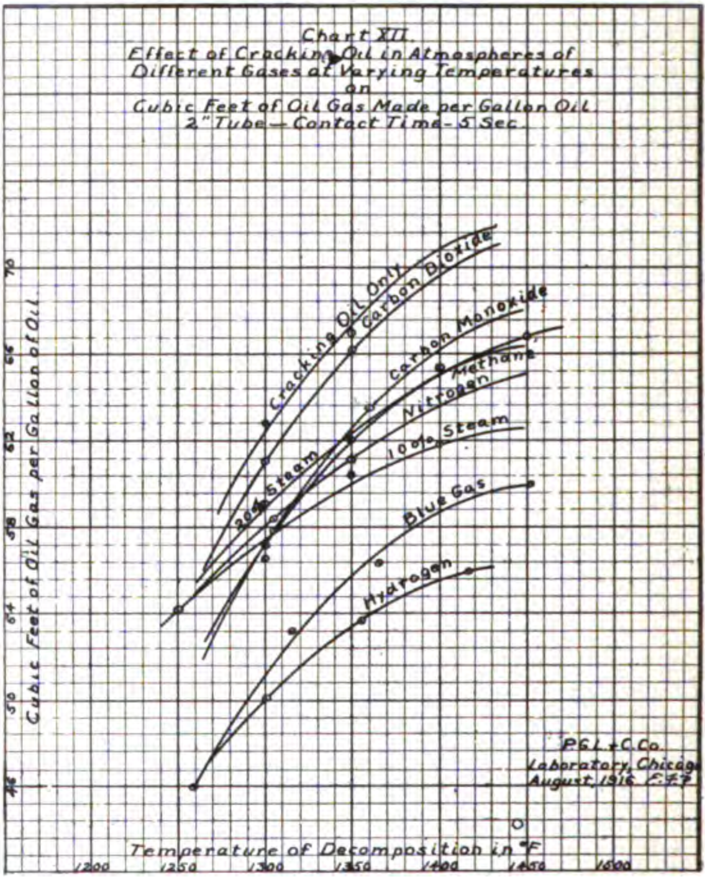
When oil is conducted into the cracking chamber, in the absence of any surrounding atmosphere, the effect of a longer time of contact and greater concentration of oil vapors can be clearly seen. The candle-power cannot be read accurately on a Bray burner since the gas burns with a large smoky flame and the maximum efficiency of the flame is not developed.

The B. t. u. per gallon is very low. Only 80,000 B. t. u. were obtained from the same oil which gave 97,000 when accompanied by nitrogen. This fact illustrates the tendency of the oil gas to decompose into simpler compounds and carbon. It will also be noted from Chart XII that a much higher yield of oil gas is obtained by volume. This gas is largely methane. Chart XI-*b* shows that the weight of oil gas found is small while the tar formation is exceedingly high.

A comparison of the results from cracking in the presence of nitrogen and cracking oil alone, as illustrated on Chart XIII-*b* shows that the illuminants are very easily decomposed with the formation of methane. At the temperature of 1,300° F., the illuminants decreased in volume from 25 feet to 19 feet due to the increased time of exposure. If the illuminants are considered to be mostly ethylene, the reaction occurring may have been

$$C_2H_4 = CH_4 + C_2.$$

This being true we would expect an increase in methane in the case of cracking the oil alone by about 6 cubic feet. Ethane when present in a gas is equivalent to twice its volume of methane and its probable decomposition to methane is affected by hydrogen thus,



$$C_2H_6 + H_2 = 2CH_4.$$

Considering the volume of ethane as two volumes of methane, the increase in methane content at longer time of contact is 7 cubic feet. The volume of hydrogen does not change.

Again at 1,350° F., the decrease in illuminants is 9 cubic feet while the increase in methane is about 8 cubic feet. This fact would seem to indicate that the reaction

$$C_2H_4 = CH_4 + C_2$$

is the predominant one. Some condensation of the illuminants may have occurred however. The fact that there is little difference in the hydrogen content indicates the reaction

$$CH_4 = C + 2H_2$$

does not occur to any extent at these temperatures and under the conditions imposed.

Carbon Dioxide.

When the fires in the generator are in poor condition large amounts of carbon dioxide will be produced. It is known that each per cent. of the carbon dioxide in the finished gas decreases the candle-power by about 2 per cent. When the oil was decomposed in the presence of such a poor quality of blue gas the loss in candle-power was 5.5 per cent. for each per cent. difference in carbon dioxide in the finished gas, or 3.6 per cent. for each per cent. difference in carbon dioxide in the blue gas.

When an atmosphere of carbon dioxide alone was used, the candle-power could not be measured with the Bray burner, because the gas would not burn when issuing from the jet. The B. t. u. per gallon of 95,000 is less than that obtained with blue gas. The volume of the gas made was good, being over 60 cubic feet per gallon. This gas, however, was very light, containing much hydrogen and methane, so that the weight of gas produced from the oil was low.

The tar production was lower than that obtained with blue gas or hydrogen. The noticeable effect of carbon dioxide was the increased production of carbon (Chart XI-*a*). At 1,350° F. a yield of 25 per cent. was observed while in blue gas the ordinary production is about 10 per cent.

Carbon Monoxide.

The cracking of oil in a carbon monoxide atmosphere gave rather surprising results. The great loss of candle-power is noticeable. This is in accordance with the investigations of Dr. Elliot on "The Effect of Diluents on Candle-power."[10]

The candle-power was low because of the effect of the large proportion of carbon monoxide in the finished gas and it would necessarily follow that the candle per gallon results would also be inferior.

The B. t. u. results (Chart X) were the lowest obtained with any atmosphere, excepting, of course, oil acting alone with a much longer time of contact. The volume and weight of gas produced are good, being much better than the results with carbon dioxide or nitrogen.

Carbon monoxide appears to be a direct cause for the production of tar, since more tar was produced in this atmosphere than any other (Chart XI-*b*). The carbon depositions on the other hand are low.

It also appears that the carbon monoxide is instrumental in preserving the illuminants from decomposition (Chart XIII-*b*). Less hydrogen was generated in cracking the oil in carbon monoxide and the yield of illuminants was good.

A theoretical consideration of the action of carbon monoxide and dioxide upon the preservation of the illuminants and hydrocarbons leads one to expect that the results should be similar to what were actually obtained. For example take the reaction:

$$C_2H_4 + 2CO_2 = 4CO + 2H_2.$$

The conditions of equilibrium are expressed by the equation

$$K = \frac{p.\ CO^4 \times p.\ H_2^2}{p.\ C_2H_4 \times p.\ CO_2^2}$$

It is evident, since K, the equilibrium constant, has a definite value for each absolute temperature, and since the partial pressure of any constituent is proportional to its volume, that the conditions favorable to preserving or preventing decomposition of the ethylene will exist when the volumes of carbon monoxide and hydrogen are higher and the volume of carbon dioxide is low. Now an examination of the results obtained at 1,350° F. shows that in carbon dioxide 28.2 cubic feet of illuminants were produced while in carbon monoxide 30 cubic feet were made from a gallon of oil. Thus it will be seen that carbon monoxide does exert a preservative effect on the illuminants.

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[10] *Proceedings American Gas Institute*, 1912, p. 331.

It appears possible also that the carbon monoxide is instrumental in aiding the oils to decompose more extensively into high molecular weight olefines, which pass into the tar, and ethylene or propylene, which increases the percentage of illuminants in the gas.

The effect of mass action is also noticeable in the carbon monoxide atmosphere. The presence of large amounts of carbon monoxide results in a slight absorption of that gas. In other atmospheres there was usually a small production of carbon monoxide. The probabilities are that carbon monoxide in solution in the water of the holder or meters is the contributing cause for this production. But it has also been demonstrated by Whitaker[11] that cuprous chloride solution will absorb such paraffine hydrocarbons as ethane, propane and butane. This absorption would be indicated as carbon monoxide in an analysis and no doubt often accounts for the presence of carbon monoxide in the gas made.

When an atmosphere of carbon dioxide was used, however, some of the carbon dioxide was decomposed, for an absorption of 4 cubic feet per gallon of oil was noticed. This absorption was accompanied by a production of 3.4 cubic feet of carbon monoxide which is in accordance with the equation cited.

There are usually so many reactions taking place and so many equilibrium conditions to be considered in connection with oil decomposition that it is almost impossible to predict just what the ultimate outcome will be, whereas if only one reaction were to be considered it would be a comparatively easy matter.

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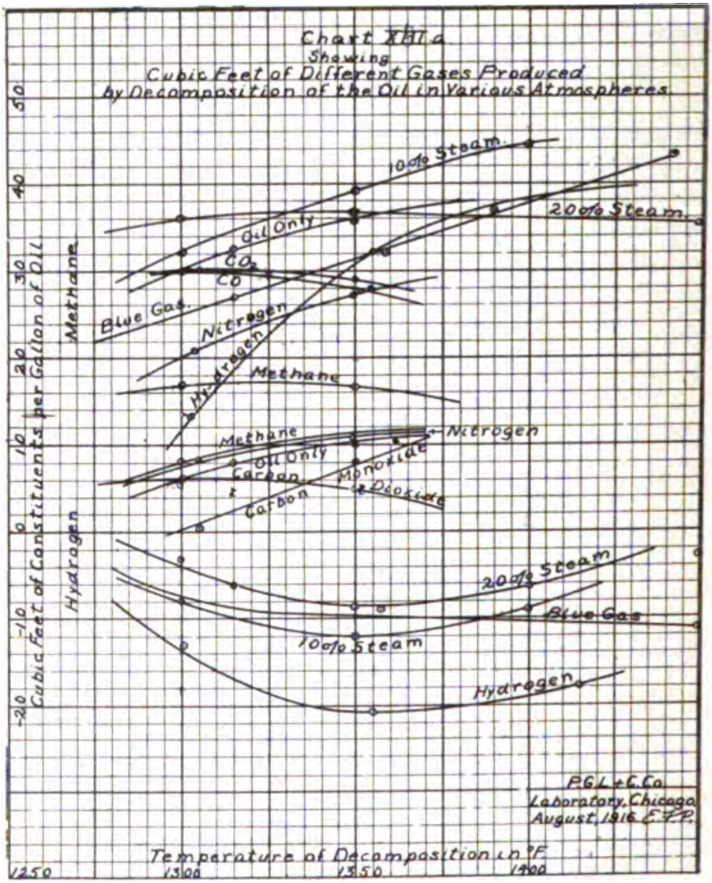
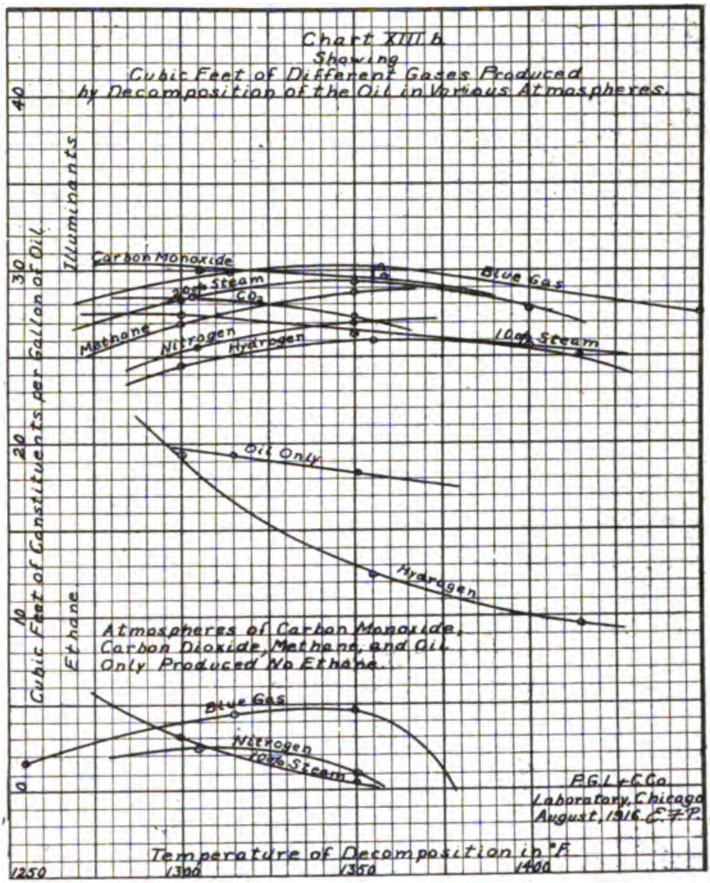
[11] *Journal Industrial and Engineering Chemistry*, July 1916, p. 599.

Hydrogen.

The action of hydrogen is the most interesting of all the gases examined. It was expected that candle-power and candle per gallon results would be high. As a matter of fact these results were lower than those obtained in an atmosphere of blue gas containing about 50 per cent. hydrogen. The volume of gas made is high. This is an indication that absorptions have taken place. From Chart XIII-*a* it is seen that an



absorption of hydrogen has actually occurred amounting to as high as 20 cubic feet per gallon of oil. This absorption has resulted in the formation of saturated compounds, such as ethane and methane. It is of interest to note that at 1,300° F., 19 cubic feet of ethane were formed per gallon of oil and only 1.3 cubic feet of methane (Chart XIII-*b*). As the temperature increases the ethane decomposes and methane is formed so that at 1,400° F. the production of ethane is 9 cubic feet



and that of methane 37 cubic feet. At higher temperatures the ethane would be entirely decomposed.

The production of illuminants (Chart XIII-*b*) is seen to be low. Apparently some of the unsaturated compounds have been hydrogenated forming saturateds. The reactions occurring are probably

$$C_2H_4 + H_2 = C_2H_6,$$
$$C_2H_4 + 2H_2 = 2CH_4,$$

the latter occurring at high temperatures, the former at lower ones.

The illuminants have approximately the same photometric value as those produced in atmospheres of blue gas. The heating value of the illuminants is slightly lower. This would seem to indicate that hydrogenation of the higher olefines such as propylene and butylene occurs first, and that ethylene is more stable, being able to withstand decomposition. Further evidence tending to establish this theory is the fact that the specific gravity of the illuminants produced is lower and very close to that of ethylene. Since all the errors of the analysis enter into this calculation it is probable that the results are a trifle low.

Hydrogen has an influence in producing high B. t. u. gas, because of the great production of saturated compounds. The decrease in the volume of gas made is the reason that the B. t. u. per gallon is not higher (Chart X).

Again when excessive amounts of hydrogen are present the tar production is lowered, also the amount of carbon deposited. The decrease in tar formation is probably caused by greater hydrogenation of the lighter olefin compounds which ordinarily would have passed into the tar.

Methane.

When the oil was cracked in an atmosphere of methane the best candle-power results were obtained. This may be due to the fact that methane itself possesses a candle-power of 4.5 when burned at the rate of 5 cubic feet per hour. The volume of gas made compares favorably where no absorptions occurred. Hence the candle per gallon figures are also good.

As a whole methane acts very much like an inert atmosphere, such as nitrogen or carbon monoxide, since the weight of tar and carbon produced is quite large. The effect of mass action is also seen in Chart XIII*a*. It will be noticed that much less methane was produced from the oil when the methane was already in the surrounding atmosphere. On the other hand the production of hydrogen is larger, an indication that the reaction

$$CH_4 = C + 2H_2$$

is occurring more extensively than in other atmospheres.

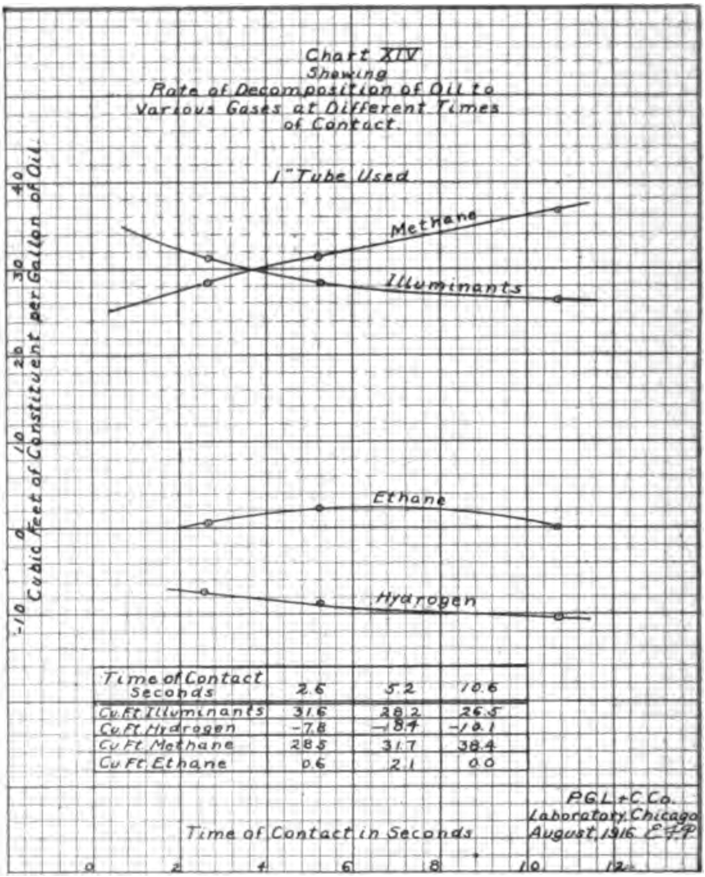
The effect of methane on the illuminants is also probably preservative, since the presence of this gas introduces equilibrium conditions which prevent the hydrogenation of the unsaturated compounds.

Blue Gas.

A comparison of the action of the various atmospheres discussed, with that of blue gas, leads one to the conclusion that no advantage is to be gained over blue gas by the use of any of these atmospheres alone. It would not be beneficial to pass a scrubbed coal or oven gas through the carbureter or superheater while enriching with oil, neither would a natural gas used in such a manner add enough gain in the efficiency of oil cracking to offset the cost of such a procedure.

It is of much interest to note that blue gas, when used, gave much better candle-power results than either hydrogen or carbon monoxide alone. The lower proportions of carbon monoxide in the finished gas greatly diminish the deleterious influence of that constituent on candle-power, while the smaller proportion of hydrogen present decreases the loss of volume due to absorptions. The tar formation is lowered and carbon depositions are medium. The B. t. u. results are also greater than those obtained in any single atmosphere.

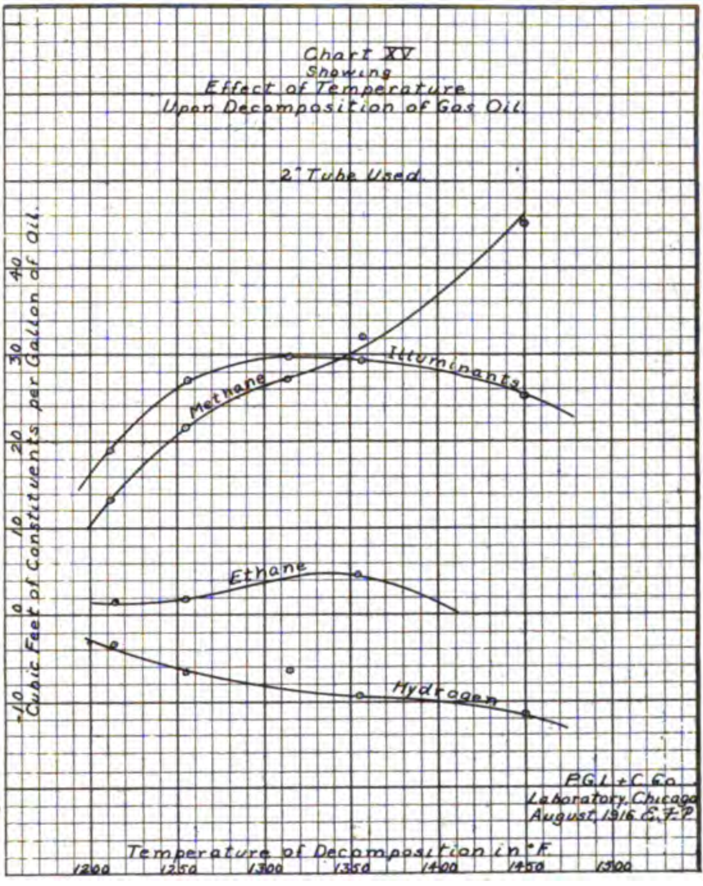
It is rather difficult to trace the reactions which have occurred in the carbureting of water gas. Charts XIV and XV are submitted to show the general tendency of decomposition, *viz.*, the effect of increasing temperatures and also of increased times of contact on the production of the various constituents. It is to be noted that the illuminants formed from a gallon of



Time of Contact Seconds	2.6	5.2	10.6
Cu. Ft. Illuminants	31.6	28.2	26.5
Cu. Ft. Hydrogen	-7.8	-8.4	-10.1
Cu. Ft. Methane	28.5	31.7	38.4
Cu. Ft. Ethane	0.6	2.1	0.0

oil gradually increase and reach a maximum at about 1,300° or 1,350° F. Higher temperatures cause the decomposition of these illuminants.

It is generally conceded by all authorities that when an oil dissociates the primary products are the higher molecular weight olefines and lower molecular weight paraffines. Further decomposition results in the production of carbon and hydrogen. For example we may assume decane ($C_{10}H_{22}$) to decompose as follows:



$$C_{10}H_{22} \rightleftharpoons C_9H_{18} + CH_4$$

$$C_9H_{18} + H_2 \rightleftharpoons C_9H_{20}$$

$$C_9H_{20} \rightleftharpoons C_8H_{16} + CH_4$$

or in general

$$C_n H_{2n+2} \rightleftharpoons C_{n-1} H_{2n-2} + CH_4$$

Paraffine = Olefine + Paraffine

$$C_{n-1}H_{2n-2} + H_2 \rightleftharpoons C_{n-1}H_{2n}$$

Olefine + Hydrogen = Paraffine

$$C_{n-1}H_{2n} \rightleftharpoons C_{n-2}H_{2n-4} + CH_4$$

Paraffine = Olefine + Paraffine

A consideration of the results in Chart XIV will show that this reaction has taken place extensively. The illuminants which consist mostly of ethylene are hydrogenated, forming methane and some ethane. The longer the vapors are acted upon the greater is the proportion of methane produced and the hydrogen absorbed, while the illuminants decrease. On the other hand such reactions as

$$CH_4 = C + 2H_2$$

did not occur to a marked extent, since if this had happened one would expect an increase in the hydrogen present in this oil gas. The volume of hydrogen formed should have been noticeable, whereas there was always an absorption. Extremely high temperatures favor the latter reactions however.

From the work with blue gas it is difficult to state whether oil decomposes with the formation of hydrogen. This is probable but the amount present in the finished gas is usually less than that in the blue gas. At temperatures above 1,500° F., the reverse has been noted, and is probably due to the decomposition of methane to carbon and hydrogen. The hydrogen absorption varies from 6 to 10 cubic feet at the usual temperatures of operation.

As has been already noted methane is the main primary decomposition products of the oil formed by hydrogenation of olefines. It gradually increases until temperatures above 1,600 are reached.

Ethane is also a primary decomposition product but we rarely obtained more than 5 cubic feet per gallon. The usual temperature of formation was from 1,250° to 1,350°. At

1,400° F. the ethane has all decomposed, probably according to the reaction

$$C_2H_6 + H_2 = 2CH_4.$$

The disappearance of the ethane is usually accompanied by a large increase in methane content. The reactions

$$C_2H_6 = C_2H_4 + H_2$$

and

$$C_2H_6 = C_2H_2 + 2H_2$$

do not occur extensively as some have believed, since if this were true one would expect a larger increase in illuminants and hydrogen than was actually found. These reactions do occur to some extent at higher temperatures and longer times of contact than are usual in operating practice. As a matter of fact increasing times of contact result in greater hydrogen absorptions and a decrease in illuminants. This indicates that the conditions are not suitable to ethylene formation.

The Effect of Steam.

Steam is always present in the blue gases passing through the carbureter and superheater, especially at the end of the run. The steam exerts a detrimental effect on candle-power and candle per gallon results, as can be seen from Charts VIII and IX. The B. t. u. per gallon of oil produced is high. This may be due to a partial decomposition of the steam into hydrogen, since the weight and volume of oil gas produced is greater than that in blue gas without steam. Steam also gave lower yields of tar and larger carbon depositions. Much reliance can not be placed on these figures, however, since the weight of water used was deducted from the total weight of tar and water condensed. Irregularities in the drawing of the tar greatly effect the results and also some decompositions of the steam occurred.

A consideration of the theoretical equation

$$C_2H_4 + 2H_2O = 2CO + 4H_2$$

and the equilibrium conditions connected with it leads one to expect that an excess of steam would cause a decomposition of hydrocarbons. Such has been the case. At 1,300° F. about 30 cubic feet of illuminants were produced in the dry blue gas. The same temperature with finished gas containing 10 per cent. of steam yielded only 27.4 cubic feet of illuminants. When 20 per cent. steam admixed with blue gas was used, 28.2 cubic feet of illuminants were produced.

The higher percentage of steam also seemed to allow the maximum production of illuminants to occur at a slightly higher temperature. The ethane did not dissociate so rapidly when more water vapor was present. Apparently the presence of excess steam is not injurious to the operation of a water gas set from a B. t. u. standpoint, but it is decidedly so from a photometric point of view. Besides the presence of much steam is an indication of poor blue gas and longer times of contact, all of which are very injurious to good operating results.

Appearance of Flames.

The appearance of the flames when the gas formed in the various atmospheres was burned in the Bray burner is no doubt of interest. Carbon monoxide causes the flame to be small and very bright. Hydrogen causes the flame to be large and unsteady, but not very brilliant. Methane gave a very large flame but rather deceiving as the candle-power was not as high as might be expected from casual observance. No appreciable difference could be noticed in the burning of the blue gas—oil gas flame from that of blue gas steam—oil gas.

This paper has been presented with the hope that it may serve as an aid in a better understanding of the carbureted water gas process and be of assistance to some in their efforts to discriminate between good and bad qualities of gas oils.

MR. O. B. EVANS (Philadelphia): It is a great pleasure indeed to listen to such a carefully prepared and excellent paper as the one just read by Mr. Downing. I am particularly interested in this work because we ourselves have been paralleling it to some extent, and the results obtained agree, in general, very closely with those quoted by Mr. Downing.

The chart given on page 609, showing the effect of candles per gallon when using different oils, is of particular interest. Of course, we rather expect that the presence of methane, by increasing the heating value of the gas and producing a higher flame temperature, will increase the apparent candle-power, but it is rather remarkable that both constituents of blue gas, carbon monoxide and hydrogen should each give a lower result than the combination of the two. Mr. Downing has given an explanation of this apparent inconsistency. I feel, however, that this point opens up a large field for further investigation.

In determining the candle-power of a gas we should be very careful to differentiate between the efficiency of the burner and the true candle-power of the gas. It is well-known that one particular gas may produce the same quantity of light when burned in burners of different types, whereas another quality of gas may produce an entirely different effect, and for this reason it is questionable whether tests of gases of widely varying candle-power had not better be compared upon a scientific burner of the Carpenter type rather than upon the open-flame burner.

Mr. Downing rather suggests that some of the fractions of a gas oil produce higher candles per gallon than do others. While we have not gone into that subject very carefully, we have nevertheless taken some oils and made fractional distillates of them, and have cracked these fractional distillates separately in our apparatus. The results do not seem to indicate that such fractional treatment has any beneficial effect. Apparently, the value of a gas oil depends, to a great extent, upon the proportion of the various hydrocarbon series present, and these hydrocarbons are probably present in the same proportion in both the low and high boiling fractions.

Most of the analyses given by Mr. Downing showed that the quantity of so-called illuminants produced is about 28 cubic feet per gallon of oil, and that the quantity does not vary much within a comparatively wide range in cracking temperatures.

Our experiments seem to check this belief. We have determined, however, that the calorific value of the so-called illuminants may vary from 2,200 B. t. u. per cubic foot down to 1,700 B. t. u. per cubic foot, and that the candle-power produced from the same volume of illuminants will vary as much as 30 per cent. This leads to the suggestion that since a given volume of illuminants will have a varying calorific value and will produce a gas of varying candle-power, the composition of these illuminants must also vary. If a ready method of determining the actual composition of the illuminants could be devised, undoubtedly much of the uncertainty of the gas business could be eliminated.

MR. FULWEILER: Mr. Downing should be congratulated on presenting one of the most interesting papers we have had before the Chemical Section of the American Gas Institute.

As a chemist, however, I feel that there is still great opportunity for work to be done toward identifying an oil by its chemical and physical characteristics, as this would enable us in a short time and with a small sample to get data that would otherwise require several days and several gallons of oil.

I would call attention to one point in Mr. Downing's discussion of the physical characteristics. This relates to the variation of the refractive index with the specific gravity. It is quite true that roughly, these vary together, but by calculating what is known as the specific refractive index there will be found quite a divergence between various samples. The specific refractive index of the four series calculated on compounds having a value of $N = 6$ would be about as follows:

Olefines	0.5702
Paraffines	0.5605
Naphthenes	0.5429
Aromatics	0.5731

With regard to the fractional distillation, I believe that 100° fractions are entirely too large and that in investigating a gas oil, we should make the fractions as close together as possible, and that a study of these fractions, particularly with reference to the specific gravity, refractive index, and specific refractive index would reveal valuable information.

As far as the ultimate analysis goes, this may yield information of value, particularly the hydrogen and carbon ration. Sulphur, of course, is of some importance from the standpoint of purification, but the percentage of hydrogen varies in the five series which Mr. Downing considers (assuming $N = 18$) from about 15 per cent. in the paraffines, to about 12.2 per cent. in the aromatics, so that I feel that since we agree that the paraffines are the most valuable series that the percentage of hydrogen is quite important in predicting the probable usefulness of the oil.

With reference to the way in which Mr. Downing places the various series of hydrocarbons, from a mathematical consideration of a larger number of tests, we place the naphthenes below the aromatics in value. This, however, was unfortunately no easy method of proving this actual test.

There is one factor that I feel has very great influence on the candle-power efficiency of the gas oil that has not received the consideration that it deserves. This is the composition of the illuminants, particularly the condensable vapors. Some experiments indicate that there is a very great variation in illuminating value of say benzol compared with xylol and that probably some of the erratic results that have been obtained in experiments of this kind were due to a variation not in the total quantity of the illuminants produced but to their composition.

In connection with the fractional distillation of gas oils, I have seen some experiments that indicated that the first, second, third and fourth, quarters of an oil as separated by a fractional distillation gave practically identical enriching efficiency, which is quite contrary to many of the old ideas that we had on the distillation test as a means of identifying a good gas oil from a poor one.

I think after we read Mr. Downing's paper, we cannot but smile at the way we used to look at the rather rough distillation of a gas oil and its gravity and pronounce it good or bad without further investigation.

PROF. A. H. WHITE (Ann Arbor, Mich.): I can appreciate the great amount of work that has been put on this by Mr. Downing, and the valuable results, but I haven't had time to go into it enough to attempt any analysis of it.

If we consider the process of destructive distillation from the theoretical standpoint we find that the first step must always be a splitting of the original molecule into at least two smaller molecules, some of which may later polymerize to a more complex tar. We should expect that the products of low-temperature distillation of the paraffines would not polymerize so readily as the products from oils of the cyclic series and that, therefore, the oils of the cyclic series would give us more tar and less gas than oils of the paraffine series heated in the same manner.

THE CHAIRMAN: Are there any other remarks? We have a written discussion from Mr. E. C. Uhlig of Brooklyn, which I will ask the Secretary to read.

MR. E. C. UHLIG (Brooklyn, N. Y.): (Written discussion communicated.) The authors are to be congratulated on obtaining results that agree within 5 per cent. of works results, when one considers the complicated nature of water gas sets. It is comparatively easy to maintain any desired temperature in a small experimental apparatus, but not so easy in the carbureter of a water-gas set. This is evident from a consideration of the following: A pyrometer only indicates the temperature at the end of the couple and while this temperature may be constant in the small space of the cracking tube, it certainly is a large variable throughout the area of a carbureter. It is well known that the temperature of the carbureter at the end of the blow will show a great difference in different places. The top will be perhaps 400° hotter than the bottom, the intermediate places showing a gradual tapering off of temperature until the bottom is reached. Besides this the checkerbrick will give a different contact effect to that of the small furnace. Another consideration is that the small furnace may be maintained at a constant temperature, while the large carbureter is becoming cooler during the run. All these variables in the carbureter must exert an effect on the results obtained from the oil different from those obtained in the experimental apparatus. The fact that Mr. Downing's results are very close to works results would indicate that the effect of the variables in the large carbureter are not as great as usually supposed. A tabulated comparison carried over a period of time, of results obtained by this apparatus and regular works practice would be very interesting.

We have made similar cracking experiments producing oil gas only. While our work has not gone as far as that of the authors we found that fair comparisons could be made provided the different oils were cracked under the same conditions. We had no trouble in making candle-power tests of oil gas when we used a suitable burner. The burner chosen was that which gave the highest candle-power when the gas was burned just below the smoking point, A No. O Bray consuming about 1 cubic foot per hour was found quite satisfactory, the candle-power being corrected to 5 cubic feet per hour. Of course, such results could not be compared with works results, but they showed quite some differences with different oils.

The effect of steam on oil gas alone showed an increase in candle-power. This might be expected as the steam was a protection to the oil vapors. The candle-power results obtained by the authors corresponds to works candle-power but nothing is said of the effect of cooling on this candle-power. Or, in other words what of the district candle-power which after all is the important point. Falling off of candle-power due to cooling depends greatly on the formation of aromatic hydrocarbons during gasification. I think some data on the formation of these hydrocarbons during gasification would be of the greatest interest.

THE CHAIRMAN: If no one has anything more to add to the discussion, I will call upon Mr. Downing to close.

Mr. R. C. Downing (Chicago): I would like to consider the questions that were brought out in this discussion by Mr. Uhlig first, chiefly because it takes up the question of the design of the machine. He mentions that it was rather surprising to him that we obtained as good as 5 per cent. difference in our results from station results. I think that this is largely due to the efficiency of the engineering department of the Peoples Gas Light & Coke Company. And another thing, the time of contact of the vapors in a water-gas machine is somewhat shorter than what we were able to obtain in the laboratory. In some previous work done, I have found that the time of contact was one of the important factors which influenced the results obtained in cracking an oil. Theoretically one would expect better results in laboratory cracking because of the ability to control conditions to a greater extent. It was rather surprising to ourselves also, when we first noted the close agreement between laboratory and work results.

Mr. Uhlig also mentions the graduation of the temperatures, which exists in a gas machine, and its probable effect on results. We did some work in connection with a previous paper written for the Illinois Gas Association in which we varied the temperatures from 300°, that is from the entrance of the cracking tube to the exit, and then reversed the conditions. We found that there was about 0.1 of a candle per gallon advantage to be gained in keeping the temperature higher at the top of the carbureter. We also found that when we arranged the temperature in this order that the candle per gallon results, considering the average temperatures, were about 0.4 lower than we were able to obtain if we kept the temperature uniform.

Mr. Uhlig has also mentioned the probable effect of different spacing of checkerbricks. Well, we gave the question of the design of the machine very careful consideration. I would like to read an extract from the previous paper that I have written to show how we went about this.

"A typical large gas machine was used as a basis of design; such a machine was assumed to furnish 17,500 cubic feet of gas per run of 5 minutes. The oil input was taken at 15 gallons. At a working temperature of 1400° F. about 65 feet of oil gas would be formed per gallon of oil used, and about 11 gallons of tar produced per run. The gas made was assumed to be 30 per cent. oil gas and 70 per cent. blue gas, containing 15 per cent. excess steam. Free space of the machine was taken and 1,700 cubic feet and heating surface of brick walls, arches and so forth, at 11,350 square feet. With such a machine the time of contact of the oil vapors with heated surface has been calculated to be about 4 seconds.

That is what I have calculated. Mr. Spitzglass calculated with his device for measuring the make of gas from individual machines, that it would be as low as that, sometimes as low as 2 seconds.

"The ratio existing between the total square feet of heating surface and the total cubic feet of free space in the machine is about seven to one. The ratio between the actual surface of the brick and the free space between the brickwork is about twelve to one. The latter appears to be the more correct as a basis of design since the greater part of the carbureting work is done in the brick."

Now, in this 2-inch cracking tube the ratio is twenty-four to one, and so we really get a greater action by the heat upon our illuminants and gases. But I might say that we have contemplated further work and we want to determine, if we can, more about the effect of spacing, so we have built a larger machine, constructed along similar lines. The tube is 8 inches in diameter, and we intend to put different sizes of baffles inside of the tube to see if we can determine any further information of value, concerning the proper spacing of brick for any given set of conditions.

Mr. Uhlig also mentions some of the results of cooling the gases, or he states that it is very important to know how our gas is going to hold up after it gets out on the street. We have made some tests to determine this drop on a few oils. We did not find very much difference in candle-power drop with the few oils tested and did not continue the work. Lately

I have given more consideration to the question and think that further investigation may show that there is a relation existing between the composition of the oil and the condensation formed. A larger amount of the low-boiling fractions in the oil may be the cause for more condensation in the line.

Now, to take up the discussion by Mr. Evans. He said he would like to know if I had any further explanation as to why the results obtained in hydrogen were lower, and the results obtained in carbon monoxide were lower than what I obtained with blue gas. The only answer I have for this is that when carbon monoxide is used as a cracking atmosphere and the gas burned in a Bray burner that it has a very marked effect in reducing the candle-power because of the great amount of carbon monoxide present, 58 per cent. At dilutions with 30 per cent. of carbon monoxide the candle-power is not lowered to such a great extent. Dr. Elliott has written a paper in which he has shown this effect. Then on the other hand when hydrogen is used I brought out the fact that there was a great absorption, and that this would result in a big decrease in the gas made per gallon at higher hydrogen concentrations. Combining these two effects, when the proportion of carbon monoxide is decreased and the hydrogen decreased we really should get better results, as is the case with the blue gas. Mr. Evans asked if that was a theoretical equation quoted on page 616. I will state that it is a theoretical equation, but I think that it applies to a very small extent.

He also mentions the importance of the burner in taking the candle-power. Some of our best oils which I know ought to give better results, did not give them because they were burned at the rate of 5 feet an hour in the Bray burner, and I do not believe they fully developed the candle-power that was in the gas.

He also states that he did not get as much difference in the different fractions which he distilled and tried out as I did. I have not done very much work on the machine described with the different fractions. My conclusions are really based on a small machine of 1 inch in diameter where I cracked only the oil gas alone, and I think the subject is also worthy of further investigation.

As to the matter of 38 cubic feet of illuminants which he produced, I might say that we have only been able to produce as much as 28 with a maximum of 32 on the best oil tested. That difference seems to be greater than could be caused by different methods of analyses, although with Mr. Evans, I think it a matter of importance for the Institute to standardize gas analyses, that gas analyses may be uniform throughout the country so that when one section does a piece of work, another man can interpret the work correctly.

In regard to the discussion by Mr. Fulweiler. He states that he believes the chemical tests are of value. I also believe that the chemical tests will be of value as quick tests for the valuation of gas oil.

The real reason why the work in connection with this paper was done was to try to establish the relationship existing between the chemical tests and the actual value of the oil from the cracking tests.

He also discusses the refractive index. I might state that I have not done any work on the refractive index, and the statements I made about it were taken from the Bureau of Mines *Bulletin,* some of the work done by Mr. Rittman. He states that the specific gravity and the refractive index are very close together. I appreciate the fact that they certainly will differ on different oils.

As to the reason why I distilled the oils at fractions of 100°, it has been the practice of the company for years back to distill the oil that way, and we really wanted to get, first of all, some results with which we could compare oils we used. I agree with Mr. Fulweiler that it would be much better to use a shorter range between those boiling points when closer research is desired.

As to the ultimate analysis, I also took results from ultimate analyses published by different authorities. While I believe that a higher hydrogen content is very important as an indication of a greater amount of paraffines, the results from different authorities which I considered showed many inconsistencies. I believe that these were due to errors in the analysis since it is a very difficult one to make correctly. And there is no reason why, with one man making the analysis, that he should not be able to obtain consistent results. On the other hand it is rather difficult, and we wanted to develop a quick test which the average station chemist could use to determine the value of his oil. For this purpose the ultimate analysis is too complex.

With regard to the naphthenes, I have taken the results and the statements that have been published by others, for the simple reason that I have never been able to obtain an easy way of separating the paraffines and the naphthenes. I think it would be an interesting line of work if a naphthene oil, olefine oil and paraffine oil, were cracked and then we certainly would know what the value of each was. I made no attempt to nitrate the oils but can readily see that it may be of much value to do so.

With regard to the steam. We held the time of contact the same in each case but we did not consider the effect of partial pressure. I realize there would be a lower pressure in a machine with steam present. But again, in some of the work done by the Bureau of Mines it has been shown that when cracking under pressure it is necessary to reduce the pressure an enormous amount and almost reach a complete vacuum before you get different results.

THE CHAIRMAN: I think it is the sentiment of the Section that I thank Mr. Downing for his very able paper.

There is one more item on the program, the report of the Committee on Central Testing Laboratories. Will the Secretary please read it?

REPORT OF CENTRAL TESTING LABORATORY COMMITTEE.

Your committee was appointed in compliance with an invitation from the National Commercial Gas Association to the American Gas Institute, requesting the latter to appoint a com-